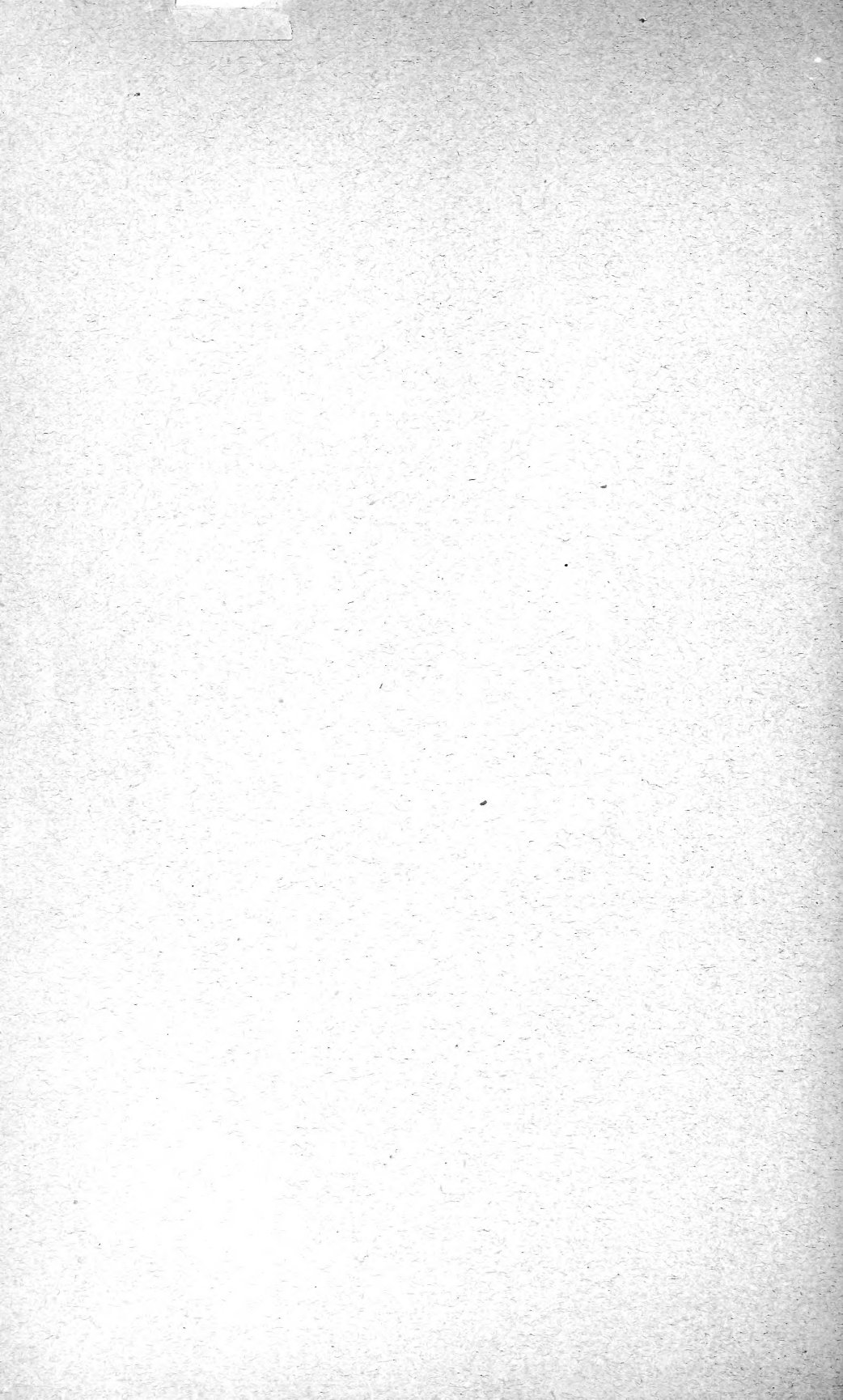


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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN No. 13

B. T. GALLOWAY, Chief of Bureau.

EXPERIMENTS

IN

RANGE IMPROVEMENT

IN

CENTRAL TEXAS.

BY

H. L. BENTLEY, SPECIAL AGENT,
GRASS AND FORAGE PLANT INVESTIGATIONS.



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LETTER OF TRANSMITTAL

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., November 23, 1901.

SIR: I have the honor to transmit herewith a paper on Experiments in Range Improvement in Central Texas, and respectfully recommend that it be published as Bulletin No. 13 of the Bureau series. The paper was prepared by Mr. H. L. Bentley, special agent, Grass and Forage Plant Investigations, and was submitted by the Agrostologist.

Respectfully,

B. T. GALLOWAY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

PREFACE.

Central Texas is a semiarid region, and is naturally one of the best grazing or live-stock sections in the Southwest. The native grasses which, prior to 1875, were most abundant in variety and quantity have been to a great extent destroyed, so that the carrying capacity of the ranges has been greatly diminished, but there are enough grass roots left to make the restoration of the pastures to their former condition possible at comparatively small expense. The experiments at Abilene were undertaken to demonstrate the truth of this statement, and the report of Mr. Bentley, special agent in immediate charge of the work, will be of more than ordinary interest, not only to stockmen of central Texas, but to all engaged in the cattle industry on the western ranges, as showing how the result in view was accomplished. What has here been done under Government direction may be done by individuals. In fact, the primary object of this report is to invite attention to the methods pursued and the actual results attained that all interested may take advantage of the experience acquired in the work. The results have demonstrated the practicability of reclaiming the worn-out ranges in central Texas, at least, within a reasonable time and expense. The land selected, which was a range below the average quality, was leased to the Department by Mr. C. W. Merchant for use in these experiments, and was fenced, in accordance with our directions, by the citizens of Abilene, and to this extent the work was cooperative with the people of that town. At the beginning of the experiments the carrying capacity of the pasture selected was 40 head of mixed cattle to the section, or 1 to 16 acres. When the experiments were concluded on April 1, 1901, the carrying capacity was estimated to be 100 head of mixed cattle for the 640 acres, or an increase of more than 100 per cent. The actual cost to the Department did not average more than 25 cents per acre per year, or 75 cents per acre for the three years. The rental of the 640 acres had doubled in actual value as the result of the three years' experiments, or, we will say, had risen from \$5 an acre in 1898 to \$10 an acre in 1901, giving a net increase of \$4.25 per acre, or \$2,720 for the section.

This office is under obligations to Messrs. D. W. Middleton, J. W. Parramore, and W. J. Bryan, of Abilene, Tex., who during the term acted as station inspectors and in many other ways cooperated and aided materially in this work. To Mr. P. O. Forbus, also of Abilene, who during three full years was foreman of the working force of the station and in many ways contributed to whatever success was secured, acknowledgments are also due.

F. LAMSON-SCRIBNER,
Agrostologist.

OFFICE OF THE AGROSTOLOGIST,
Washington, D. C., November 19, 1901.

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EXPERIMENTS IN RANGE IMPROVEMENT IN CENTRAL TEXAS.

INTRODUCTION.

It has been written that he is a benefactor of the human race who makes two blades of grass grow where but one grew before. May it not be said with as much reason that he who destroys the single blade is a menace to civilization? At all events, the suggestion opens up an interesting line of thought, and it may be well worth the effort involved to consider very briefly the present conditions of central Texas and the Southwest generally.

The capacity of this section for carrying live stock has been, during the past fifteen or twenty years, diminished from 30 to 50 per cent as the result of either bad management or a reckless desire on the part those who occupied it to "get rich in a hurry."

In *Grazing Problems in the Southwest, and How to Meet Them*, prepared by Jared G. Smith, under the direction of the Agrostologist, it is stated that the Secretary of Agriculture, fully appreciating these conditions, directed the Division of Agrostology early in 1897 to begin investigations of the forage problems and conditions throughout the regions of the Southwest with instructions that particular attention be given the native grasses and forage plants, their abundance and value, their preservation, and the possible methods to be employed in restoring the former carrying capacity of the ranges.

In line with these purposes, Mr. Smith visited central Texas in the spring of 1897. Finding there a condition of affairs that, in view of the large area of country included in his proposed field of work, called for a more extensive investigation than he could make in person, the writer was requested to undertake and make the investigations and submit a report upon the grasses and forage plants of central Texas. It was further suggested that the existing condition of the cattle ranges of the Southwest generally be looked into; that the causes of the radical exhaustion of the pasturage of central Texas particularly be determined, as far as practicable, and that a history of such exhaustion, with suggestions for its restoration, be submitted. This special commission having been approved by the Agrostologist, the writer

entered upon the work, and as a result of his investigations submitted two reports covering the same. One, A Report upon the Grasses and Forage Plants of Central Texas, was published in 1898 as Bulletin No. 10, Division of Agrostology, United States Department of Agriculture; the other, Cattle Ranges of the Southwest, was published the same year as Farmers' Bulletin No. 72 by the same Department. The former contained brief accounts of the physical character of central Texas, the early and (then) present condition of the ranges, and descriptions and general observations upon the distribution and economic importance of a large number of the grasses and forage plants natural to the region. The latter report was a history of the exhaustion of the pasturage of central Texas particularly, with suggestions for its restoration. These two reports were applicable to a territory 200 miles long and 150 miles wide, between the ninety-eighth meridian and the western edge of the Staked Plains. As one result of these investigations and reports, it was decided to obtain control of a body of overgrazed land in central Texas in order to carry on, during three years, experiments in methods of practical range improvement. In March, 1898, Prof. C. C. Georgeson, then connected with the Division of Agrostology, was sent to Texas to select the land. He chose 640 acres near Abilene, and Prof. Jared G. Smith was commissioned to establish the work. In April the writer was appointed special agent in charge of this work, really the first ever undertaken either by the General Government or by State experiment stations.

The report here presented covers the work done under this appointment during the period between April 1, 1898, and April 1, 1901.

The central Texas country, to quote from Farmers' Bulletin No. 72, above referred to, includes all of the counties of Stonewall, Haskell, Throckmorton, Fisher, Jones, Shackelford, Nolan, Taylor, Callahan, Runnels, Coleman, Tom Green, Concho, and McCulloch, and parts of the counties of Kent, Scurry, Mitchell, Coke, San Saba, Brown, Eastland, Stephens, and Young. It embraces a territory about 100 miles wide east and west and about 200 miles long north and south.

The characteristics common to these counties are:

(1) An open country in the main, with some black-jack, post-oak, and live-oak timber on the uplands and ridges.

(2) A scattering growth of mesquite trees on the lands away from the streams, which, together with the timber on the streams, furnishes ample firewood and posts for fencing purposes.

(3) Numerous streams that furnish an abundance of "stock water," fringed along their banks with groves of pecan, elm, hackberry, wild china, cottonwood, and other trees.

(4) An altitude ranging from 1,500 to 1,900 feet above the sea level.

(5) A climate pure and bracing.

(6) An annual rainfall of about 20 to 35 inches, the average being about 30 inches, so distributed through the year that it suffices for range purposes, but periodically is not quite enough for the best results in farming.

(7) A temperature ranging from 90° to 102° down to -6° F.

(8) A rich alluvial soil in most of the valleys, while on the uplands there are loams generally containing a large admixture of calcareous marls, varying in color from a light gray through all the intermediate colors—chocolate, mulatto, red, brown—to black; all productive and susceptible of high cultivation, and especially rich in all the essentials for the production of cereals and grasses.

(9) A great variety of forage plants and rich grasses.

Stonewall, Nolan, Mitchell, McCulloch, Coke, San Saba, and Taylor counties, by their mountains, level plains, and rolling prairies, present a greater diversity of surface than the others. In Taylor County there are elevations of considerable altitude, one mountain range extending through it from southeast to northwest, the highest point being 519 feet above the surrounding plains. In Throckmorton, Stephens, Shackelford, Callahan, Runnels, Coleman, and Tom Green counties there are some broken areas. In the other ten counties named there are comparatively few hills and practically no mountains, the prevailing characteristic topography being the rolling or undulating prairies. In all of these counties where there are neither mountains nor hills the general surface is gently undulating, except in the immediate vicinity of the streams, where it is rough and sometimes cut up by canyons.

To the end that a proper understanding may be had of the weather conditions that prevailed here during the three years' work mentioned, the following monthly condensed data are given from the figures specially prepared for this report. They indicate the highest, lowest, and mean temperature, and the total and mean precipitation, in inches, during each month of the three years above mentioned:

	Temperature.			Total precipitation.
	Maxi- mum.	Mini- mum.	Mean.	
1898.	$^{\circ}$ F.	$^{\circ}$ F.	$^{\circ}$ F.	Inches.
April	92	34	65	1.78
May	101	43	73	2.60
June.....	98	61	78	4.55
July	102	62	81	1.46
August	98	61	81	1.94
September.....	100	46	75	3.44
October.....	94	30	66	Trace.
November.....	81	24	51	.98
December	78	1	39	2.14

RANGE IMPROVEMENT IN CENTRAL TEXAS.

	Temperature.			Total precipitation.
	Maximum.	Minimum.	Mean.	
1899.	°F.	°F.	°F.	Inches.
January	72	8	42	0.51
February	78	—6	37	.01
March	93	23	58	.04
April	94	27	63	2.96
May	94	54	74	4.02
June	93	62	77	5.45
July	102	64	81	1.38
August	104	72	87	.10
September	97	52	76	.44
October	92	44	69	2.90
November	80	28	57	2.36
December	78	24	44	3.24
1900.				
January	76	17	47	.92
February	77	14	46	.53
March	88	31	56	1.54
April	84	33	63	5.43
May	91	51	70	4.11
June	105	63	81	.30
July	96	65	81	2.59
August	100	64	81	2.11
September	96	57	77	9.65
October	91	42	68	4.39
November	81	31	56	.24
December	70	15	48	.30
1901.				
January	81	15	49	.03
February	77	13	43	1.44
March	88	23	56	.72

In the four periods as above indicated are the thirty-six months during which the station work under consideration was carried on. The work covered three periods of twelve months each—April, 1898, to and including March, 1899; April, 1899, to and including March, 1900; April, 1900, to and including March, 1901. The averages of the temperature and precipitation for each of these three periods were:

	Temperature.			Precipitation.	
	Maximum.	Minimum.	Mean.	Total.	Monthly mean.
	°F.	°F.	°F.	Inches.	Inches.
First period	90 $\frac{7}{12}$	32 $\frac{1}{2}$	62 $\frac{1}{8}$	19.45	1.628
Second period	91 $\frac{1}{2}$	39 $\frac{1}{2}$	63 $\frac{1}{12}$	25.84	2.153
Third period	89 $\frac{5}{8}$	39 $\frac{1}{2}$	64 $\frac{5}{12}$	31.31	2.608

It will be noticed that the total precipitation during the first period of twelve months was 19.45 inches, an average of 1.628 inches per month, about 10.55 inches less than normal. The next twelve months

the total increased to 25.84 inches, still 4.16 inches less than normal. During the last year of the work the total was 31.31 inches, over 1.31 inches above normal. The work, therefore, was inaugurated under local conditions that were very unfavorable for good results. In the detailed report to follow it will be explained how such conditions militated against the work and prevented the best results; and yet, on the whole, the results actually secured were encouraging, and demonstrated the practicability of reclaiming the worn-out ranges within a reasonable time and at an expense that should not discourage farmers and stockmen. Up to within a few years past the average farmers and stockmen of the Southwest were little inclined to adopt any other than "the old regulation methods" of farming and handling live stock that had been in vogue "since the time when the memory of man runneth not to the contrary," as the old law books stated the idea. In other words, the "book farmer" was looked upon by the regulation or orthodox farmer as "a crank," a visionary sort of creature to be respected for his enthusiasm, but to be avoided in matters of business. He was deemed impractical by the men who prided themselves on being "practical farmers," but who were constantly putting into practice methods that for all practical purposes were "out of date" and wrong. Fortunately, the farmer who reads, studies, experiments, and adopts scientifically correct methods is no longer sneered at by those who are less advanced than he. They are still slow to accept his advice and adopt his methods, even when they must see or recognize their superiority to the old-time methods. In good time, however, they will accept his way of thinking and doing, and though their apparent lack of interest in the more advanced methods of farming is somewhat discouraging to those who are willing to aid them, nevertheless, year by year, a large per cent of them are reading, studying, and experimenting for themselves. In like manner, stockmen who, a few years ago, were satisfied to follow the "seven and six" plans of the old times, are beginning to realize the common sense in the latter methods, and are manifesting a strong inclination to adopt the up-to-date ways.

During the first year of the work under consideration a large number of farmers and stockmen of central Texas called at the grass and forage plant station "to see what they could see." Not a few of them were emphatic in their expressions of disapproval. During the last year of the work much interest was manifested in it, and though much too small a number of those who have followed and approved of the work, and now testify to the practical results secured, have concluded to adopt similar methods on their own properties, it is believed that many others will adopt them later. As one stockman said in the autumn of 1900, "Seeing is believing, and a half-blind man can see that this range is the best in this section, while before the Govern-

ment took it in hand it was one of the very poorest." Another remarked: "Don't think that because every stockman in these parts hasn't taken up the methods adopted here they are blind or indifferent. Many of them have been watching and taking notes, and are quietly making experiments on their own places, and I predict that the others will do likewise."

The world is slow to adopt anything new, but once let it be demonstrated that it pays to do so, and no people are more ready to take hold than are the farmers and stockmen of the United States. Hence, it is reasonable to believe that within a few years advanced methods of handling the ranges will be adopted in central Texas and throughout the Southwest generally, and that where one blade of grass now grows in a very few years several will be made to grow. The soil of these ranges is quite as rich in food for grasses and forage plants in 1901 as it was thirty years ago. The seasons are as good, in fact better, in that the rainfall is somewhat greater and is more satisfactorily distributed. Hence the belief that after the proper methods for rejuvenating the ranges shall have been generally adopted, it will not be many years before the range capacity for sustaining live stock will be quite as great as it was in the sixties and seventies, when there was no better stock country to be found than that of central Texas.

HISTORY OF THE FIRST YEAR'S WORK.

SELECTION OF THE LAND.

In March, 1899, Prof. C. C. Georgeson, of the Division of Agrostology, was sent by the Agrostologist to select a section of range land on which it was proposed to undertake and prosecute experiments "to demonstrate the most practicable, and at the same time the most economic, way of treating the natural pastures in order to again cover them with the native grasses or with other species from similar regions in other countries." He put in several days looking over the many sections recommended to him for the purposes in view. Some of them were already fairly good ranges, but he was looking for one that had been run down until it was distinctly a very poor range. Some of them were valley lands altogether, the soils being uniformly rich and specially favorable for the growth, under favorable conditions, of grasses and forage plants, but he was looking for one that was poorer and if anything less favorable for range purposes than the average. He was acting on the idea that if a body of land already stocked with grasses, or one specially located, or specially rich in the matter of its soil, should be selected, no matter how successful might be the results of the experiments to be made, they would not be accepted as demonstrating the correctness of the methods adopted. There would be many who could say, with some reason, and would, in

fact, say that "anybody could take as rich a range as that, with a good lot of grass to begin with, and make a favorable showing under fair conditions." What the Agrostologist wished to secure was results which, if satisfactory, would be accepted as being due to the putting into practice of correct theories and pushing them on correct lines. That is what Professor Georgeson had in mind when he selected an irregular body of land containing 640 acres lying about $4\frac{1}{2}$ miles southwest of Abilene, in Taylor County. The following diagram of the land, with the explanation to follow, is submitted:

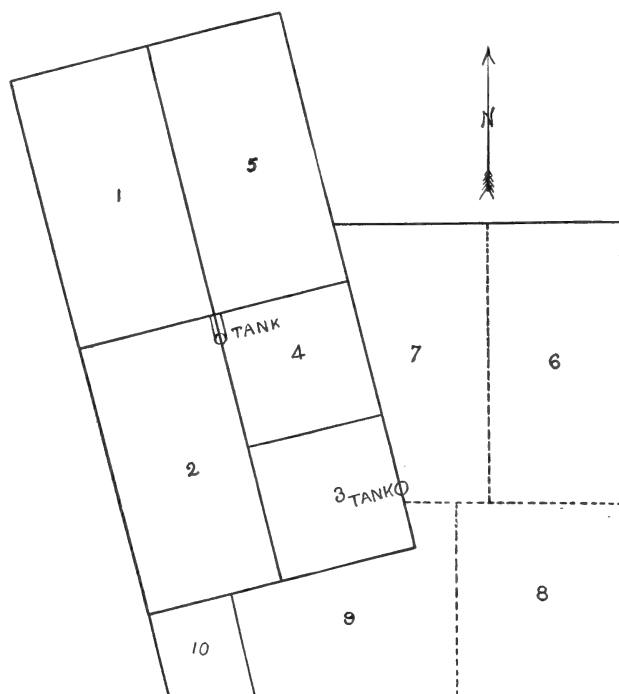


FIG. 1.—Plan of the station grounds.

Mr. C. W. Merchant, who owned the pasture which included this 640 acres, had authorized Professor Georgeson to cut out all he cared to use in any shape to suit himself. There was no running water on any part of the tract selected, but through each of the subdivisions indicated were the beds of dry branches and holes that held water after copious rains, the water flowing into Elm Creek of the Brazos River, which supplied in the main the stock water for the entire Merchant pasture. Next to these branch beds were level lands known, locally, as "second valley lands," to distinguish them from the valley lands lying next to the creeks and rivers. All of these valleys were narrow, and extending out from them were lands known, locally, as "the

uplands," being level stretches, as a rule, above the valley levels, though in the north parts of subdivision Nos. 1, 5, 7, and 8 were rough hills which were considerably higher than the surrounding lands. The purpose of taking in these rough valley hills was to make it certain that a lot of very poor and unpromising land, as well as some average level uplands and some valley lands, might be included. As Professor Georgeson explained.

If these hill lands, rough, gravelly, and rocky, very poor in quality, and now almost destitute of grass or grass roots, can be reclaimed, it will mean much more to farmers and stockmen than the reclaiming of level and comparatively rich valley lands will mean to them.

How well he succeeded in his efforts to locate the grass and forage-plant station on land below the average of the neighboring lands in favorable position, quality of soil, and quantity of grass and grass roots then in sight, the significant remarks of visitors to the station and the further facts to be hereafter stated will assist in determining.

Ex-Congressman J. V. Cockrell, of the Thirteenth Congressional district of Texas, visited the station in 1899, and remarked: "You have here about the roughest and poorest section of land in all this part of the country;" and it was quite the expected and the usual thing for visitors to the station, in 1898, to notice and comment on the fact that the land was evidently not selected with the view to securing the best. The valleys and uplands, outside of the hills, were of fair average quality as compared with the other rough lands in that part of Taylor County, but the hills mentioned were exceptionally rough and the soil very thin. It was in order to take in these hills, and also some of the richer small valleys, and a fair average of the uplands, that the 640 acres were selected in the very irregular shape indicated (fig. 1).

PLAN OF EXPERIMENTS.

Having secured the land, Professor Georgeson returned to Washington, and Prof. Jared G. Smith, then Assistant Chief of the Division of Agrostology, took charge of the work; but in a short time, his services being more essential elsewhere, he was recalled to Washington, and the writer was placed in charge as special agent, and continued in charge to the latter part of March, 1901, when, the three years' work having been completed, the station was restored to Mr. Merchant.

The section was divided by survey lines into six portions of 80 acres each, and one of 70 acres, the remaining 10 acres being set apart as a grass garden to be devoted to the cultivation of grass and forage plants. It was originally contemplated that all of the division surveys, as shown in the diagram, should be fenced, but in fact, those indicated by the dotted lines were not. The five pastures and garden fenced included 330 acres, and the four subdivisions not divided by fences,

310 acres. The work of the subsequent three years, as planned, was as follows:

Pasture No. 1 (60 acres): No treatment except to keep all stock off until June of each year, pasturing the balance of the season.

Pasture No. 2 (60 acres): To be cut with a disk harrow and stock to be kept off until June 1 of each year, pasturing the balance of the season.

Pastures Nos. 3 and 4 (40 acres each): To be grazed alternately, the stock to be changed from one pasture to the other every two weeks, thus allowing the grasses a short period for recovery after each grazing.

Pasture No. 5 (60 acres): No treatment except pasturing until June 1 and keeping stock off the balance of the season.

Pasture No. 6 (60 acres): No treatment, except to keep stock off during the first season.

Pasture No. 7: To be harrowed with an ordinary straight-toothed harrow and stock kept off during the first season.

Pasture No. 8 (60 acres): To be disked and stock kept off during the first season.

Pasture No. 9 (70 acres): Reserved for special experiments, viz, to determine—

(1) Whether or not seeds of a number of wild and cultivated varieties of grasses, and forage plants exclusive of the grasses, could be sown directly in the sod with satisfactory results.

(2) Whether the roots of certain sod and pasture grasses could be transplanted to the bare spots and a good stand secured in that way.

(3) Whether the stand of grass could be improved by opening furrows across the pastures, in which the grass seeds blown over the ground by the winds could be arrested and the stand of grass be improved.

The results of these several experiments, with the necessary details, will be stated hereafter.

CARRYING CAPACITY OF THE PASTURES.

In order to determine from year to year the extent of the improvement, if any, in the range conditions, it was necessary to ascertain the capacity of the section for sustaining stock at the very start of the work. To that end, three well-known stockmen of central Texas were invited to make a full and painstaking inspection of practically every part of the section. They were C. W. Middleton, J. W. Paramore, and W. J. Bryan, all of Taylor County and all old settlers in that part of the State, each a large owner of cattle, and, therefore, specially interested in the results to be secured. That each one of them could accurately estimate the capacity of a range to sustain stock no one in the Southwest, where they are extensively known, could for a moment doubt. It was believed, therefore, that an expression of opinion by them on the subject would be accepted as definitely determining the capacity of the particular section under consideration. They made a personal and minute inspection of every acre of the section on March 23, 1898, and unanimously reported that its utmost capacity at that time was the support of mixed stock at the rate of 1 head to every 16 acres, or 40 head to the section, in the proportion of 10 cows with calves, 15 yearlings, and 15 two-year-olds. Mr. Middleton, who during several years prior to 1898 had held his

cattle in a large pasture which at that time included this particular 640-acre tract, is authority for the statement, made by him to his associate inspectors, that when he first knew it, in the seventies, its capacity for supporting cattle was quite 160 head of mixed cattle to the section of 640 acres, including the hills mentioned. He explained that the large difference between its present and its former condition was due to the fact that, in common with all the other range lands of the section, it had for years been overstocked. Prior to the date of its purchase by Mr. Merchant, only a short time before 1898, it had first been part of the open range in which everybody's cattle roamed at will, and later had been held under lease; and in each case the cattle roaming on it had been permitted to graze it closely. This was the situation, say, April 1, 1898, and the problem to be solved was: "Is it practicable, as the result of carefully planned, systematic work, to take this land, which once had four times its present capacity for sustaining stock, and restore it to its original value as a pasture?"

SEEDING THE GROUND.

Before Professor Smith left he personally superintended the experimental work as planned to be done on pasture No. 9. He had several acres sowed, without disturbing the surface, to the seeds of quite a variety of grasses and forage plants, including several of the weeds recognized by stockmen as having definite value as early stock feed. He also made an effort to get a stand of Texas blue grass and curly mesquite by transplanting fragments of sod to the bare spots, but on account of the dry weather that followed practically none of the seed sown germinated, and all of the sods put in the ground died. He also had the 10-acre garden tract broken, but necessarily, it being sod land, the breaking was shallow—only deep enough to turn under the sod. On this tract he sowed broadcast seeds of many varieties of grasses and several varieties of alfalfa, and later several varieties of cowpeas and velvet beans.

A shower following these sowings, some of the seeds germinated, but after a brief effort to exist only the alfalfa, cowpeas, and teosinte survived the distressing shortage in rainfall that followed. The precipitation during April, 1898, was much below normal, being only 1.78 inches, and the maximum temperature was 92°, much above normal. There were only 2.60 inches of rainfall during May, and the temperature for the month was abnormally great, the maximum being 101°. During June the precipitation was satisfactory, being 4.55 inches, but it came too late to save the garden work. In July the temperature went to 102°, and the rainfall fell off to 1.46 inches. During the next month the weather continued favorable, the rainfall being 1.94 inches, the temperature ranging between 81° and 98°. September promised more satisfactory weather, but while the rain-

fall was 3.44 inches, the heat continued excessive, reaching as high as 100°. There was but a trace of rain during October, and the mercury remained up in the nineties, and went up to 94°. In November less than 1 inch of rain fell, and during the next three months there was not enough to materially raise the average for the twelve months, the precipitation during December being 2.14 inches, only 0.51 inch during January, 1899, and only 0.01 inch during February following. The oldest settlers of central Texas still talk feelingly of the memorable drought year of 1887, but it is a fact that there was even less rainfall in 1898 than in 1887. Early in the spring cattle had been placed in the station pastures, and as long as the stock water lasted the plans for handling them, as set out above, were carefully followed, but from time to time the water supply gave out between rains, and the cattle had to be taken to other pastures in which there were streams of running water. By the end of November the effort to hold them even temporarily in any of the station pastures was abandoned.

When the garden tract (10 acres) had been planted, as stated, its only fence was 5 strings of barbed wire. Soon after the alfalfa, cowpeas, and teosinte began to grow the prairie dogs and jack rabbits from every point of the station and from the outside moved en masse to them, destroyed nearly all the alfalfa roots, and did considerable damage to the velvet-bean and cowpea vines and the teosinte. Enough seed of the cowpeas was saved for another year's trial. The velvet beans, in spite of the long-protracted hot weather and the short rainfall, made a surprising vine growth, but they bloomed and the abundant crop of pods formed too late to mature a crop of beans before the frosts of October, which were much earlier than usual for that section. The teosinte made a vigorous growth of 18 to 32 inches, when the drought began and the growth stopped, the roots being too far gone to do well when the fall rains set in. The roots survived the drought and the shoots made some growth until frost, but no seed matured.

As a result of these several garden experiments a report was made to the Agrostologist under date of November 24, 1898, in which it was suggested that with normal amount of rain during the next year it would be practicable to demonstrate: (1) That alfalfa of all kinds could be grown successfully without irrigation in central Texas; (2) that teosinte would prove a splendid forage plant for the section—in fact, superior for forage purposes to any of the sorghums as tested to date; (3) that the velvet bean would prove a crop of much value; (4) that all of the several varieties of cowpeas, which had been experimented with to date, would be shown to be available crops for forage purposes; (5) that practically no definite results had been secured so far as the grass seeds sown were concerned, only a few of the varieties having germinated, none of them having developed satisfactorily on account of the drought. It was also suggested that the work had given sufficient

promise that definite, tangible results on similar lines, of much benefit to the farmers and stockmen of central Texas, would be secured as the result of further experiments. In the matter of the efforts to secure range improvement as the result of harrowing and disking three of the 80-acre pastures, it was suggested that they had proven satisfactory and justified the belief that a rapid increase in the quantity of grass on the overstocked pastures was practically assured.

This work was done during March and April, and the rainfall during May (2.60 inches) was satisfactory to the extent that notwithstanding the hot weather heretofore mentioned the grass in the three pastures was very much better than that in the station pastures not treated and in those in the same neighborhood outside of the station. In two of the pastures a disk harrow was used which every 4 inches cut furrows from 3 to 6 inches deep, as the surface of the ground was harder or softer, or gravelly, or free from gravel. In the other pasture treated an ordinary iron-tooth harrow was used, heavily weighted at times, the effect being to scarify the surface as thoroughly as possible. There was rather a heavy growth of mesquite trees growing in each of the pastures, and it was not possible, therefore, to cut into every acre of the ground.

In this connection it may be well to explain that the theory on which this work of harrowing was done was: (1) That by cutting into the ground by disk or harrow teeth the grass roots would not necessarily be injured, but on the other hand would be given a better chance for development through the looser ground below the surface; (2) the surface runners from the grasses would be given softer ground in which to take root readily; (3) the storm waters would be saved instead of being allowed to run off into the lower places, and thence into the creek beds and rivers, and the rain would go into the ground where it fell and directly to the grass roots; (4) seed beds would be made in which the grass seeds, as they fell to the ground, or were blown over the hard ground elsewhere by the winds, would be arrested and find suitable places in which to germinate.

Notwithstanding the drought of 1898, there was a very marked improvement in the conditions of the several pastures treated. During the latter part of March, 1899, just one year from the first inspection above mentioned, Messrs. Middleton, Parramore, and Bryan made a second inspection of the station and unanimously reported that the conditions during the year had improved so that the section of 640 acres, taken as a whole, had in March, 1899, a capacity to support mixed cattle at the rate of 1 head to every 10 acres, or 64 head to the section. During the next month Messrs. Middleton and Bryan made another visit to the station, again carefully inspected the pastures, and reported that the capacity of the section for mixed cattle was then at the rate of 1 head to every 8 acres, or 80 head to the section. This was after the

spring rains had begun to fall and the grass was making growth. The gains as reported by the committee were phenomenal, considering the fact of the drought of 1898, being 100 per cent in a single year, and, had the station pastures been stocked during the year to their capacity, as recommended by the committee in March, 1898, it would have been fair to take the result as demonstrating the correctness of the theories underlying the methods adopted to improve the range. But on account of the droughts the pastures were not stocked nearly as heavily as had been recommended during a considerable part of the year, and it was still an open question whether the improved condition of the station pastures, especially those which were harrowed and disked, was not quite as much due to the fact that they had been rested at the season when the grass seeds were maturing and dropping as to the fact that the surface had been treated.

CONCLUSIONS FROM THE FIRST YEAR'S WORK.

At the end of the first year's station work the facts as above set out were reported to the Agrostologist, and the conclusions as submitted were:

(1) That it will pay farmers and stockmen of Texas, especially in the semiarid regions of the State, to cultivate their pastures by use of disk and iron-tooth harrows.

(2) That it will pay them to rest their pastures periodically during the seasons when the grass seeds are maturing and falling to the ground.

It was believed then that the results of the station work to that time, under the conditions set out, clearly demonstrated the correctness of these conclusions, and later results have confirmed them.

HISTORY OF THE SECOND YEAR'S WORK.

EXPERIMENTS WITH VARIETIES.

The conditions under which the work was continued into the second year were very difficult. In the first place the continuous extreme cold during the months of January and February was very unfavorable for experimental work. During January the thermometer frequently indicated several degrees below freezing point, and during February there were but eight days when the temperature was above 32°. The month of January was dry, even for that section, the total precipitation being only 0.51 inch. During February it was but 0.01 inch—practically nothing—and only 0.04 inch during March. During the autumn of 1898 the 10-acre garden tract had been plowed deep with a turning plow, the purpose being to expose the earth to the freezes to follow and to save every drop of rain that might fall there.

Notwithstanding the dry weather of January and February and to March 15, this ground was in fair condition to receive seeds at the last-mentioned date. It contained but little moisture, but on account of the freezes during January and February it was easily pulverized. In anticipation of rain, planting of grass and forage plant seeds was begun March 15 and continued until May 4. During April the rainfall was about normal for the season, namely, 2.96 inches, but on account of the dry weather and the cold condition of the ground during March many of the seeds planted that month did not germinate. Those that did germinate, however, grew rapidly, and as the rainfall during May and June was all that could reasonably have been desired, everything in the garden, including the weeds, grew very rapidly. The garden had been laid off in plots 20 feet square, separated into subdivisions, according to the quantities of seeds on hand. As a rule the seeds were sown broadcast, hence it was impracticable to use plows in fighting the weeds, and in the effort to get rid of them by hand weeding much damage was necessarily done, some plants being trampled and many others pulled up with the weeds. All these difficulties were exceedingly discouraging, but they suggested methods that later were adopted with eminently satisfactory results.

During July the temperature rose to 102° , and the rainfall fell off from 5.45 inches in June to 1.38 inches. Hot winds blew nearly every day during the month, and by the 1st of August the garden plants, which up to about the end of June had been full of sap, presented the appearance of having been scalded, where they were not actually dead. During August there was but one rain, and that only 0.10 inch, on the 16th, and during September there was but 0.44 inch, on the 7th. From that time to October 16 there was practically no precipitation, and then it was only 0.01 inch, and from the 16th to the 26th the conditions were about as unfavorable as could be imagined. Nevertheless, many of the garden plants to be hereafter specially mentioned survived, and when the drought of 1898, scarcely less severe than that of 1887, was broken on the 26th of October, it was surprising how many of them were, in fact, still looking vigorous. On that date there was a rainfall of 2.89 inches, and at once the several varieties of alfalfa, sulla, sanfoin, and vetches began to green out, and between then and the early frosts of November each made an astonishing growth.

No attempt will be made here to give the details of the very many grass-garden experiments conceived and worked out with much care. That many of them demonstrated the impracticability of the methods adopted were not surprising; but, as emphasizing the necessity for trying others, these failures have special value.

Perhaps it may be well to mention the fact that part of the 10-acre grass garden was too rocky for cultivation at all, a part was too gravelly to be satisfactorily cultivated, and all of it was thin and dry.

The lower levels were drained of moisture by the bed of a small stream which ran through the east side of the garden and which only at times, after hard rains, held water. The soil extending from these levels was dry as well as thin. It was quite the usual thing for visitors to the station to notice and comment on the fact that a more unpromising spot for garden purposes could hardly have been selected, and this was in fact true; but they did not always note that this particular 10-acre tract was about as rich as the other 630 acres of the section, nor did they consider the very important fact that a line of successful experiments, secured under the most favorable conditions, would possess but small value in the estimation of the average farmer and stockman of central Texas. As above stated, the section as a whole was selected because it was not a rich body of land, as well as for the reason that as a cattle range it had been badly overstocked and generally abused; and the 10 acres included in the grass garden had been selected for the very reason that condemned it in the estimation of visitors generally, namely, because the soil was thin and dry and otherwise below the average of the garden land throughout central Texas.

It is well in this connection to suggest to farmers and stockmen who are interested in such work as was done in the station garden that if under the unfavorable conditions through which that work was prosecuted even a fair success has been secured, they should feel encouraged to experiment themselves on similar lines, having richer soils to depend on in the first place, and better seasons, as a rule, to look forward to. The normal average rainfall throughout the central Texas country being about 30 inches, it is prudent to figure on that much in making calculations for further experimental work.

During the first two years' work near Abilene the average precipitation was less than 20 inches during the first and less than 26 inches during the second—only 45.29 inches during the twenty-four months, when 60 inches might reasonably have been expected—a shortage of 14.71 inches. Nevertheless, as the following record will demonstrate, the grass-garden experiments were not barren of encouraging results.

True, of the several varieties of grasses tested most turned out poorly, but quite a number were found to be well suited to the semiarid regions. The greatest successes were secured with the native grasses, and farmers and stockmen of the section are earnestly recommended to give special attention to such grasses as side-oats grama, blue grama, black grama, rescue grass, buffalo grass, grapevine mesquite, and Canadian rye grass. Many others might be mentioned as being easily grown from the seed, but as the result of the second years' station work those enumerated gave the best results.

It is not necessary to tell central Texas stockmen and farmers that curly mesquite, needle grass, knot grass, everlasting grass, and feather

blue stem are valuable and worthy of their best attention. They are all natives and old-time friends, and their values are too well known to need special mention. There are many others of equal or almost as great value with which they are not familiar, and they will do well to look into their histories and study their characteristics. Of the more than one hundred varieties of grasses and forage plants tested in the grass garden during the season of 1899-1900, each one here mentioned was demonstrated to have special value. Of the millets tested the Japanese barnyard and Shama gave special satisfaction, while the pearl, broom-corn, and German millets did very well. Of the forage plants not grasses tested the best results were secured with the annual saltbush from Australia, three varieties of alfalfa (the common lucern, Turkestan, and Oasis), two varieties of the vetches (spring vetch and hairy vetch), sulla, sanfoin, several varieties of cowpeas and soy beans, velvet bean, teosinte, and many varieties of sorghum. Of the experiments made that season with several of the clovers none turned out satisfactorily.

During the third year of station work each of the grasses and forage plants tested during the other two years was again tested, with many others, and in the statement of general results (p. 37) will be found a list, with the most important characteristics of each species tested and demonstrated to be of value during the three years.

RANGE IMPROVEMENT.

It was not until April 10 that the ground in the pastures was in fair condition for harrowing. On that date harrowing was begun, and was continued, with some interruptions, until completed. During May, June, and July the growth of the grass was thoroughly satisfactory in the pastures treated with the disk and iron-tooth harrows, and the cattle that were kept on it in the proportions recommended by the inspectors were fat, sleek, and healthy. It was never possible during the three years that the station work was continued to carry out very strictly the definite plans for treating the station pastures as originally laid down, but during the twelve months from April, 1899, to and including March 31, 1900, they were substantially met. Without going into exact details on the subject, it may be stated that, taking the year as a whole, the average number of cattle as recommended was kept in the pastures. If, on account of scarcity of stock water, the number had to be temporarily reduced, the average was well made up later when it was deemed prudent to do so.

In a general way it may be stated that during the period mentioned there were held on the station pastures an average of 80 head of mixed cattle in the proportion of 1 animal to every 8 acres; and the further fact is here suggested that at no time during the year did any of the pastures indicate that they were overstocked, but, on the other hand,

it was frequently remarked by visitors to the station that even more than 80 head of stock could with safety be held on them.

At the end of the second twelve months' work, in March, 1900, the same three stockmen who had inspected the station pastures in 1898 and 1899 were again invited to make a close examination of them with the view to determine their capacity for sustaining cattle as compared with that of former years. Col. J. W. Parramore was not able to visit the station in company with Messrs. Middleton and Bryan, but about two weeks later he went over practically every acre of the section, and was impressed with the value of the treatment the pastures had received to the extent that he announced his intention of adopting similar methods in the handling of his own extensive holdings. Messrs. Middleton and Bryan also made very full and careful examinations of the station pastures, and agreed in the main in their conclusions that the harrowing and disking treatment had greatly improved the areas, though they did not quite agree in their estimates of the percentage of gain secured since their last inspection, in March, 1899. Mr. Middleton thought the gain had been fully 50 per cent in the twelve months, but Mr. Bryan thought from 30 to 35 per cent a more conservative, hence a safer, estimate.

CATCHING WIND-BLOWN SEEDS.

During this period an experiment was made that deserves more than passing notice. It is a fact well known to and recognized by central Texas stockmen that every year a large proportion of the grass seeds are lost to the ground on which they are grown and matured by reason of the fact that they are carried onto other lands by the strong winds that blow steadily during the summer months. The prevailing direction of these winds is from south to north. In order to save the seeds maturing on the station pastures, it was thought that perhaps if furrows were plowed across them about every 12 feet, say from east to west, this much-desired result might be secured. The idea was (1) that the seeds, if blown at all by the winds, would be caught in these furrows, and (2) that the storm waters that would fall in the pastures would be caught in the furrows, and instead of being allowed to waste by running into the creeks and bottoms would go to the roots of the young grass.

In May, 1899, this work was done, covering 10 acres of subdivision No. 9, next to the grass garden. By the end of June excellent results were plainly in evidence, as anticipated. The furrows had caught a great many seeds, which had gotten the benefit of surface irrigation incident to rain, also caught in the furrows. These seeds had quickly germinated and were growing vigorously, and all the grasses next to such furrows were greener and more vigorous than those farther away. The difference noted was so pronounced that in approaching that part

of the station section the course of the furrows could be easily traced by the eye quite half a mile away.

TRANSPLANTING GRASS ROOTS.

During the first two years of the station work every part of the section was overrun by prairie dogs, which were not gotten rid of until the next year. There were thousands of these pests on the 640 acres of the station land. One condition largely due to them was that there were considerable areas over the section practically bare of all vegetation. It was believed that such spots could be covered by planting in them seeds of several selected native turf-grasses, viz, curly mesquite, needle grass, cotton-top, wild timothy, black, blue, and side-oats grama, Canadian rye grass (wild rye), and everlasting grass. The seeds were planted just before rains, and in every instance they grew well and contributed in a very substantial way to the improvement of the range. Those mentioned are but a few of the many pasture grasses (all natives of central Texas and to be found in practically every one of its counties) which may be used to excellent advantage in that way, and it is recommended that farmers and stockmen make similar experiments with the view to the improvement of their pastures.

BALING LEGUMES AND FODDER PLANTS.

In all the semiarid regions of the United States, including central Texas, it is practically possible to grow every year satisfactory crops of several varieties of sorghum. There is little reason, therefore, for stockmen and farmers throughout those regions not making ample provision for feeding their live stock, even during the drought years, when their grass pastures fall short or fail entirely. It is a well-known fact, however, that the methods of curing and preserving sorghum hay have not heretofore proven entirely satisfactory. Silos have not been found sufficiently cheap to commend themselves, and of the stockmen who have tried them but few have secured good results. Shocking and ricking the fodder has not been at all satisfactory, for the reason that the juices have dried up, leaving the stalks dry and harsh and the fodder light and with little food value, while outside of the drier sections it has been found impracticable to save such hay at all, for the reason that in sweating, inevitable as a part of the curing process, the hay molds and becomes rotten and worthless. In the latter instance the trouble is due to too much moisture; in the former to the fact that the air is not moist enough.

It was believed that the sorghums, and many of the other succulent forage plants outside of the grasses, might be successfully baled, and in that way preserved, with their natural juices, for food purposes. Notwithstanding the drought, vigorous growths of several varieties of

forage plants were secured, as of the cowpeas, velvet beans, teosinte, sorghums, and alfalfas. It was determined to experiment with them and also with pearl millet and the common peanut vines with the view to ascertaining whether they could be baled and in that way preserved in good condition for feeding purposes. When the cowpeas were nearly in full bloom, and before they began to turn yellow, the vines were cut and carefully cured as for hay. Velvet-bean vines, with pods on them, but in a very immature state, were also cut, cured, and stacked. Some of the smaller teosinte stalks, which had survived the drought, were also cut, cured, and placed in shocks. Several varieties of sorghums were cut and cured when the stalks were tender and the heads in the "dough" state, and bundles of alfalfa and pearl millet were also prepared for baling. During the season all of these stuffs were baled and the bales packed away under a shed to await developments. After several months a bale of each of the stuffs was opened and examined, and in every case the hay was found to be as sweet as when first baled.

It is recommended that the stockmen and farmers of central Texas and of the Southwest generally test the value of this method of preserving the coarser forage grown on their own ranches and farms.

EXHIBITS AT FAIRS.

In the autumn of 1899 a collection of bales of hay grown on the station, including some of the baled forage plants above mentioned, was sent to the Division of Agrostology, Washington, D. C., where they were included in the general exhibit sent by the Department of Agriculture to the Paris Exposition of 1900. The Agrostologist stated that they made a very interesting and valuable part of the Government exhibit. Duplicates of the collection, with the addition of a few bales of grasses grown in the Abilene country, but not on the station grounds, were made up into an exhibit and turned over to the managers of the district fair held in Abilene in October, 1900. The display attracted much favorable attention from the large number of stockmen and farmers present, many of whom were led to take an interest in the later station work.

SUMMARY.

At the end of the second year's station work the foregoing facts were reported to the Agrostologist with a general estimate as to the results secured. In the report it was asserted that notwithstanding the adverse conditions under which they had been conducted, many of the experiments made during the year had yielded results of substantial value. They had demonstrated the availability of the alfalfas, sulla, sanfoin, the vetches, several varieties of cowpeas, velvet bean, soy

bean, teosinte, and several varieties of sorghum for annual or temporary pastures and for hay purposes. They had shown the possibility of utilizing to good advantage, for permanent pasture purposes, the seeds of such grasses as the gramas, mesquites, wild timothy, cotton top, Canadian rye, and everlasting grass. They had definitely proven that range improvement could be secured by judiciously resting the pastures, by cultivating the sod, and by sowing the seeds of hardy native and improved grasses. These and the other results secured had satisfied many stockmen and farmers that, at comparatively small expense, they could greatly improve their ranges, and that by the cultivation of many excellent grasses and forage plants, up to that time known to them only through their books and papers, they could add very much to the productive capacity of their ranches and farm pastures.

HISTORY OF THE THIRD YEAR'S WORK.

WEATHER CONDITIONS.

From April 1, 1900, to and including the month of March, 1901, when the station work was concluded, the conditions in the main were satisfactory, as were the results secured. Notwithstanding the difficulties experienced during the former two years, enough had been accomplished to give substantial results during the next twelve months.

As stated above, many of the experiments made to date had proven failures, but they had suggested and opened up the way for the adoption of better methods. Of the other experiments some had been in part successful, while still others had proven entirely satisfactory. With two years' experience, and the record well in hand as the basis for future work, that work was begun under very encouraging conditions.

The seasons throughout the twelve months, while not all that could have been desired, were good and in striking contrast to those of the preceding twenty-four months.

During April there was abundant precipitation—5.43 inches—which put the grass-garden land in excellent condition to receive seeds and the pasture lands in like condition to be cultivated and otherwise handled. During May the rainfall was 4.11 inches, which was very favorable to the growth of the garden stuffs and pasture grasses. The temperature during these two months was normal, hence satisfactory. By June 1 a large number and variety of seeds had been sown in the grass garden, and good stands of practically everything planted had been secured. The pastures selected for special treatment, as set out in the original plans, had been disked, and, owing to the abundant rains and the favorable temperature that followed, the grasses in them were developing rapidly; and the grasses in the other pastures were green and vigorous to such extent that it was considered safe to hold on the entire 640 acres of pasture land not less than 85 head of mixed

cattle. During June the rainfall was only 0.30 inch and the temperature was at times extremely trying, ranging from as low as 63° to as high as 105° , but nothing suffered very materially. During July and August the rainfall averaged about normal, being, respectively, 2.59 and 2.11 inches, while the temperature ranged from 65° to 96° during the former and from 64° to 100° during the latter month. In September the precipitation was much above normal, and was 9.6 inches during October. Throughout these two months the temperature continued satisfactory for the work in hand. During the next three months there was a decided falling off in the rainfall, which was but 0.30 inch in December, and but 0.03 in January. This shortage, however, which would have resulted in much damage to every kind of vegetable growth had it come during the normal hot weather of June, July, and August, did not seriously interfere with the grass-garden stuffs nor with the pasture grasses. Hence it was that in February, 1900, it was manifest that the year's work had been successful to that date, and promised to prove entirely satisfactory for the full twelve months, and so it turned out.

The weather during February was good, the rainfall being 1.44 inches, and the temperature averaging 43° , there being but a few days in which there was any freezing weather. In March the precipitation was 0.72 inch, and the temperature all that could reasonably be desired, its range being from 23° to 88° , the mean being 56° —strictly normal. The precipitation during the twelve months was 31.31 inches—something above the normal.

In view of these facts only good results were to have been expected, and this expectation was realized, as will be shown.

In this connection it may be well to state that the above details as to the weather during the twelve months are here given for the reasons (1) that those interested in farming and stock raising in central Texas may be advised as to what are normal weather conditions in the section; (2) that their special attention may be called to a general fact, namely, that two comparatively unfavorable seasons are very likely to be followed by one at least that is specially favorable; (3) that although the section has been in the past, and in the future is likely to be, afflicted periodically with droughts, extending over considerable periods of time, it is not impracticable during such periods to work out good results on the lines attempted on the grass and forage plant station near Abilene, Tex. Taking an average period of three years, it is practically certain that excellent results can be depended on if correct methods, based on correct ideas, are pursued. The farmer and stockman who is prepared to give up his experimental work because of a few or several failures, during unfavorable seasons, had better not go into experimental work at all, as he is certain to experience them. He who is prepared, on the other hand, to expect such

failures, under such conditions, but has the courage to push on in his experimental work, whether successful or not, through an average period of three years, is almost certain to secure results that will abundantly repay him for his expenditure of time, labor, money, and patience.

It would be difficult to imagine more unfavorable conditions than those which existed for such work as was prosecuted on the Government station near Abilene during the first two years, but by persistence, and taking advantage of the lessons forced on those engaged in it, final results were secured which amply compensated for all the trials and tribulations experienced. The central Texas stockman and farmer who will lay out for himself a three years' plan for experimental work with a view to range improvement, and will persevere through any three years, will succeed.

GRASS-GARDEN WORK.

One of the lessons learned from the former year's work was that for experimental purposes it was not best to sow any seeds broadcast, but in drills with space sufficient between the drills to admit of cultivating. Hence it was that when the season for the third year's work came on this plan was adopted and carried out to the entire satisfaction of all parties interested. As in the autumn of 1899 the garden ground (except where certain perennials, such as the alfalfas, sulla, sanfoin, and the vetches, which, having been originally sown in plots, were not to be disturbed) had been broken as deeply as practicable in the fall of 1900, in order to catch and hold the fall and winter rains and get the full benefit of the winter frosts. It may not be out of place in this connection to state that as a result of this treatment, when the time arrived to begin the spring planting, the ground was in excellent condition to receive seeds.

A FAILURE NOTED.

During the month of January, 1901, a line of experiments was tried that promised good results, but turned out, in a sense, disappointing. It had been noted that the alfalfas and clovers, especially the latter, sown during the spring months in the former years had suffered very much during the hot weather of May and June and through July, and August. It was thought that if these seeds were sown at the same time and together with such grains as wheat and rye the young plants would be protected from the hot sun by the higher stalks of the latter. Carrying out this idea, 83 rows of several varieties of rye, barley, and winter wheat, each mixed with seeds of one of the alfalfas or clovers, were planted. For instance, red-clover seeds were mixed with several varieties of wheat, rye, or barley; and in like manner other clover and alfalfa seeds. This work was begun January 4 and was continued up to and including January 31. In nearly every case a fair stand of

grain was secured, but in a large proportion of the cases the stands of clover and alfalfa were unsatisfactory, which was perhaps due in the main to the fact that, in order to put the grain seeds deep enough in the ground, the smaller seeds were buried entirely too deep. However, in practically all the rows planted some of the smaller seeds germinated, but in not a single case did the plants grow vigorously. By June 1 in spots only was it noticeable that any of the clover or alfalfa plants were alive, while the rye, barley, and wheat grew and developed well. Later, during February, and as late as during the early days of March, alfalfa and clover seeds, mixed with several varieties of spring wheat and oats, were sown, but, as in the other instances mentioned, only indifferent stands of the alfalfas and clovers were secured, and, while the uniformly excellent stands of oats grew and matured well, in no instance did the others do so.

These experiments, while they may be regarded as suggestive, are not to be taken as conclusive against the idea of mixing the smaller seeds with the larger, but they justify a substantial doubt of the practicability of the idea on which the experiments were based. If clover and alfalfa seeds be sown on ground previously seeded to any of the grains mentioned, after the latter are up, it is quite possible, even probable, indeed, that good stands might be secured, and the plants grow well. It is practically certain that such of them as did so would be much benefited by being protected by the older and larger growths from the direct rays of the hot summer sun and the hot winds. The smaller seeds might be sown on the surface and covered by means of a light harrow where the others had been broadcasted; or where the others had been drilled the smaller seeds might be drilled between rows at proper depths. In either case no serious injury need result to the young rye, barley, or wheat; but on the other hand, the probabilities are that this surface treatment of the ground would materially benefit them by killing the weeds, loosening the surface, and inducing the absorption of moisture from the air—something nearly always to be desired during the hot months in the semiarid regions.

A TENTATIVE SUCCESS NOTED.

Another experiment on somewhat similar lines may be noted. Several varieties of beans and peas having running, clinging vines, as cow-peas, field peas, and velvet and other running beans, were sown in the same rows with many varieties of sorghum. In some of the rows the peas and beans were sown with the sorghum seeds, in others when the sorghum stalks were several inches tall. In every instance satisfactory results were secured.

EXPERIMENTS WITH GRASSES.

A large number of sowings of grass seeds were made between March 28 and April 8. Practically everything that had been tested in the

two former years was again tested, with many others. In the list hereafter given will be enumerated such grasses as, in the tests made, were shown to be worth cultivating in central Texas.

NATIVE GRASSES THE BEST.

As a general rule, the native grasses did very much better than the others, and the recommendation is made to central Texas stockmen and farmers that they place less reliance on the oftentimes extravagant claims made by interested dealers in seeds, etc., as to imported grass and forage plants, and devote more attention and time to those native to their respective sections. True, many valuable additions to our native plants are the results of intelligent importations from other countries and from one section of our country to another; but experimental work with foreign grasses, etc., is very likely to prove disappointing, while there is every reason to expect good results from the cultivation of good native varieties. It is not necessary to go outside of the Southwest, or of central Texas, indeed, to find a large number of native grasses quite equal in every way to the very best of the foreign varieties that have been so industriously advertised by dealers and in the public prints. Professor Lamson-Scribner reports that there are from 800 to 900 distinct varieties of grasses native to the United States. More than 25 per cent of these are native to Texas, and within the comparatively limited territory included in what is being considered as central Texas, nearly, if not quite, 200 species are to be found, to say nothing of the large number of native clovers and other forage plants, exclusive of the grasses.

With such natural resources practically at their very doors, central Texas stockmen and farmers need not look to foreign countries, or to other States, or even to other sections of their own State, for grasses and forage stuffs that may be cultivated to the best advantage. On every natural range about them, growing on their farms, along the fence rows, and wherever else they are allowed to grow, are such as are peculiarly adapted to the conditions of soil and climate that obtain in the section. They are where they are because the soil and climate are favorable, and no experimental work is necessary to determine their adaptability and general value.

EXPERIMENTS WITH THE COARSER FORAGE PLANTS.

During this third year of station work practically every test made in the former years with the coarser forage plants was repeated and many were made with others. In the list of forage plants recommended for central Texas will be enumerated such as were found to be intrinsically valuable and adapted to the climate and soil conditions of the section. In a general way it may be stated that each of a number of varieties of sorghum was successfully grown. Some of them

were found to be better than others for fodder purposes and others were found to be better grain producers. Some matured earlier than the others, and all matured seeds satisfactorily with the single exception of teosinte, and that was shown to be very valuable as a coarser hay product.

RANGE IMPROVEMENT.

TRANSPLANTING GRASS ROOTS.

In the spring of 1898 roots of a large number of grasses found growing on or near the station section were taken up and planted in the grass garden, the purpose being to determine which of them could be utilized to advantage in efforts to cover the large number of entirely naked spots in the station pastures. Most of them gave entirely satisfactory results. In the course of the next (second) season's work this line of experimental work was very much extended, with like success. Again, during the third year's work, still other grasses were tested in the same way and for the same purpose; and the list given hereafter includes such as were found to have special value in that direction. Of the sod or pasture grasses, each of the following gave good results: Barnyard grass, Bermuda, big blue stem, black grama, blue grama, brown sedge, buffalo grass, crab grass, curly mesquite, dogtown (needle) grass, everlasting grass, galleta, grama grass, redtop, rescue grass, bur grass, side oats grama, Texas millet, white top, wild rye, and wild timothy. It may be safely stated that any and all of these species will bear transplanting, and farmers and stockmen who have bare spots scattered over their pastures, due to the ravages of prairie dogs, ground mice, and other like grass destroyers, need not hesitate to use them to quickly cover such spots. The sods may be taken up and transplanted in the early spring when the spring rains may be looked for with reasonable certainty, or in the early autumn when the rains are most likely to begin. During the month of September or October of each year, as a rule, good rains may be expected throughout central Texas. If the rainfall be less than normal during September it is very likely to be above normal during October; and if it be more than normal during the former it is not very likely to be up to normal during the latter month. In 1898 (as hereinbefore stated) the precipitation was 3.44 inches during September, with only a trace in October. In 1899 it was only 0.44 inch in September and 2.90 inches in October. In 1900 the aggregate for the two months was abnormally large, being 9.65 inches during the former and 4.39 inches during the latter month. The old-time saying that "all signs fail in dry weather" applies as well to central Texas as to any other section, but one can determine several hours, and sometimes two or three days, in advance about the time when a good rain is going to fall. The tests made in the course of the station work showed that

very few of the sods died when transplanted two or three days in advance of good rains, either in the early spring or autumn months.

THE CULTIVATION OF PASTURE GRASSES.

As already stated, the reports made by Messrs. Middleton, Parramore, and Bryan show that at the end of the first twelve months' work substantial improvement had been secured, and that at the end of the second year's work the gain in the two years had been quite 100 per cent, notwithstanding the very distressing drought of 1898 and the scarcely less protracted and severe spell of 1899. The same character of treatment of the same pastures was continued in 1900. In the early spring of that year the harrows were started, the disk in pasture No. 2 and subdivision No. 9. In the former year the disk had been set so as to cut very nearly in a straight line and not more than 3 to 4 inches deep. In this second year the lever was thrown forward so as to give to the disk an additional curve, and weights were added with the view to forcing the disks quite 4 to 5 inches deep, and so loosening the ground below the grass roots. In pasture or subdivision No. 7 there was so little grass or weeds on the ground when the first harrowing was done in 1898 that it was not difficult to force the teeth into the ground without weights. The next spring practically every acre was covered, more or less, either with grass or weeds, largely the latter, and in consequence the frame of the harrow had to be weighted. To that end heavy logs were fastened on top of it, but it was found necessary to go over and over some areas where the grass and weeds were thickest and rankest. The third spring it was found that the further use of the iron-tooth harrow was no longer practicable. On every part of subdivision No. 7 there was a comparatively heavy growth of grass or weeds, now largely the former; and no possible weighting of the harrow frame could force the teeth sufficiently deep into the ground and hold them there to do any good in the way of scarifying the surface and loosening the earth about the grass roots. Hence it was that the iron-tooth harrow was discarded and the disk harrow used instead on all three of the treated pastures. In order to secure what was expected to produce the best results, the lever was moved forward still further than in the year before, weights were placed in the disk-harrow frame, and the ground was cut from 5 to 6 inches deep and more decidedly loosened than before to that depth. In the later summer and early autumn months of 1898, and again in 1899, young grass roots were noticeably abundant all over the cultivated pastures. As this was not nearly to a like extent the case in the several pastures which had not been treated, it was taken to mean that these numerous young grass roots were in direct consequence of the special treatment given to the three pastures specified.

In the spring of 1900 Prof. Thomas A. Williams, Assistant Agros-

tologist (now deceased), visited the station and made a very painstaking and thorough inspection of every part of it, including the pastures. He was specially satisfied with the evidences mentioned of the value of the surface cultivation of the pastures, and was very positive in the expression that such evidences of the successful application of the theories on which the work was predicated were convincing. Later, in March, 1901, Prof. C. L. Shear, who in the meantime had succeeded Professor Williams in the office of Assistant Agrostologist, made an official visit to, and inspection of, the station. The effort was made during his visit to again have an inspection of its pastures made by Messrs. Middleton, Parramore, and Bryan, but Colonel Parramore was absent on his own ranch in another county, and Mr. Bryan was in Austin in attendance on the Texas legislature. In company, however, with Mr. Middleton and the special agent in charge, Professor Shear went over the pastures very carefully and thoroughly, and concurred fully with Mr. Middleton's expressions of opinion that the three cultivated pastures, in many ways, were much better than any of those not cultivated. Not only did they have on them more grass, but the variety was greater, and the grass was distinctly of a brighter color and more vigorous looking. Before the return of Messrs. Parramore and Bryan to Abilene the term of the Merchant lease of the station section terminated and the three years' work was brought to a finish; hence no final inspection of the pastures was made by the original committee. Mr. Middleton made a report in which he stated that, as a result of his several inspections of the said pastures in 1898, 1899, and 1900, and again in 1901, he was certain that in the three years ending March 20, 1901, their capacity for sustaining stock had been considerably more than doubled—a result attributable distinctly, in his opinion, to the treatment they had received in the matter of cultivating some of them, as stated, and in the systematic resting of all of them according to the original plans. During the last week of March, 1901, a special committee of three well-known farmers, who owned farms and pastures in the immediate neighborhood of the station, and who, during the entire three years, had taken deep interest in the work and had watched it closely, were requested to make, and did make, a final inspection of the station pastures. They stated in their report that they had been well acquainted with the land included in the station during all of the three years it had been in the hands of the Department of Agriculture, through its special agent, and that, as the result of the treatment of the tract under his direction, the capacity of the pastures for sustaining live stock, year in and year out, without other food than such as was afforded by the pastures themselves, was considerably more than 100 per cent greater at the end than at the beginning of the three years' work.

SUMMARY.**CATTLE HELD ON STATION PASTURES.**

It will be borne in mind that in March, 1898, the capacity of the 640 acres included in the Merchant lease was estimated by experts as being for mixed cattle at the rate of 1 head to every 16 acres—about 40 head altogether. During the third year of station work from 80 to 85 head of mixed cattle were held in the pastures, in the proportion of about 1 head to every $7\frac{1}{2}$ acres. At times the proportion was even greater, as it frequently happened that in addition to the cattle several head of horses and mules were allowed the run of the pastures. At no time, however, were the stock permitted to graze all of the pastures at the same time. The effort was made to give each pasture periods of rest in regular succession. That meant the doubling up of the stock in the pastures in which they were being held; hence it happened that during considerable periods of time the different pastures were carrying quite double as many animals as the average recommended by the inspectors. As one result of this systematic resting, the grasses in each pasture were, to a greater or less extent, permitted to mature seeds, which, falling to the ground, increased the number of grass roots and in that way added materially to the capacity of the range for supporting stock.

If Mr. Middleton and others of the stockmen who entered the country first with their cattle are correct, namely, that originally all of that section had a capacity to sustain stock equal to 1 head to every 3 or 4 acres, it is evident that the station pastures have not yet been brought back to their original capacity. What has been accomplished, however, justifies the belief that if like methods on the general line of those pursued during three years to April, 1901, be followed during the succeeding three years, as a result of the six years' work the gain will aggregate several hundred per cent. Results quite as satisfactory are certainly practicable as to every pasture in central Texas. Where but 40 head of cattle are now being held it is possible to continue to hold as many on the pastures during a first year's work and at the same time much improve them. During the second year the work of range improvement may be continued, and the number of cattle on the pastures may be increased. During the third year the number can be still further increased and the work of improving the pastures still continued. The work may be continued year after year, the work each year being proportionately greater than that of the year before; and each year the proportion of cattle may be increased. An interested stockman of Taylor County submitted the inquiry: "Do you Government station men believe that the overstocked and almost ruined grass sections of this country may be brought back to their capacity for supporting cows as back in the sixties and seventies?"

The reply was given with every confidence in its absolute correctness: "It is not only possible, but each year while it is being done cattle may be held on the pastures, the proportion increasing year after year as the capacity of the pastures to sustain them shall be increased." It was practicable April 1, 1901, to place as many as 100 head of mixed cattle on the 640 acres included in the grass and forage plant station near Abilene and hold them thereon during the succeeding twelve months without giving them other feed than they could get for themselves. But that could not be done with the 640 acres thrown into one pasture and the 100 head of cattle allowed during the twelve months to range at will over the entire pasture. It pays to build and keep up pasture fences, and every stockman should see to it that instead of one or two large pastures he should have a number of small ones, some of which can be resting while the others are doing, perhaps, double duty.

THE MATTER OF COST.

In reply to frequent inquiries submitted by interested stockmen and farmers, facts and figures have been given out from time to time as to the cost of cultivating the pasture lands. If, as many suppose, such work meant an outlay of \$2 to \$3 per acre per year, it would mean that but few pasture owners would take such work in hand. The actual cost to the Department of Agriculture of having the station pastures cultivated can not be considered as fairly determining what the cost of similar work will be to pasture owners. The Department owned no horses, did not employ men to do the work, except from day to day or from week to week, hence had to pay more for the labor in proportion than farmers and stockmen are in the habit of paying for labor by the year. It was estimated that a man working steadily with a disk harrow could go over an average of 12 acres per day and do the work thoroughly. The prices paid were: For two-horse team and driver, \$2.50 per day; for three horses and driver, \$3, and for four horses and driver, \$3.50. At times when there was plenty of work and labor was in demand higher prices had to be paid, but those named were about the average for the pasture work. Taking the highest price, as above, as a basis for calculating the cost of cultivating the station pastures, it would mean a trifle less than 30 cents per acre per year; for the three years' work, 85 to 90 cents. In fact, the cost to the Department did not average 25 cents per acre per year. Taking these figures as the basis of the calculation, it means that a 640-acre pasture would cost \$160 per year, or \$480 in three years. If the gain in the capacity to sustain stock should equal 100 per cent, it would mean that the income-producing value of the land would be doubled. If the value of the land for pasture purposes should be \$5 per acre at

the beginning of the three years' term, it would mean that it would be \$10 per acre at the end of the term. In other words, if the value of the 640 acres, for pasture purposes, should be (at \$5 per acre) \$3,200, it would be at the end of the three years' term (at \$10 per acre) \$6,400. If these figures do not quite satisfy stockmen and farmers having pasture lands greatly needing to be improved, the additional suggestion is offered that if, on the 640 acres, at the beginning of the three years' term, it should be practicable to hold only 40 head of mixed cattle, in the proportion of 1 to every 16 acres, and at the end of the first year the gain in range capacity to sustain stock should be only $33\frac{1}{3}$ per cent, it would mean that during the next year about 53 head of cattle could be held on the same 640 acres. If the gain during the second year should be a further $33\frac{1}{3}$ per cent, it would mean that about 70 head could be held in the pastures the next year. If the gain during the third year should be as great proportionately as during the first and second year, it would mean that about 93 head could be held at the end of three years on the pastures that three years before could only support 40 head. How can central Texas stockmen and farmers make money more certainly or more rapidly than by working systematically and patiently on the lines suggested? They have their own horses and will not have to hire teams to pull their harrows. They have laborers hired by the year, or they can do their own work, hence will not have to pay out anything extra for having the work done. The best times for doing the work (in the early spring or the early autumn months) are the seasons when such work can be done at odd times, when other work on the farms or ranches will not be pressing for attention.

Is it worth the effort? Do the probable large gains justify the cost?

Perhaps it will be more prudent to make a trial test on a smaller scale. On that idea the suggestion is offered that those having pastures needing reclamation make such trial tests, beginning next autumn or in the following spring. Suppose a small pasture be fenced off from the general pasture, and it be cultivated one year, and during the year it be grazed and rested alternately in periods of, say, three months, the pasture to do double duty during the periods it is pastured. If at the end of one year, the seasons having been normal, there be a manifest gain in the capacity of the pasture to sustain stock equal to 30 to 40 per cent, and if the other and larger pasture shall not have, during the same period, gained in such capacity, will not such results clearly justify a second year's experimental work, with the same small pasture, on similar lines? And if that year's work shall result as satisfactorily as that of the previous year, will the result not fairly demonstrate the advisability of still another effort to restore the pasture to its original capacity for sustaining stock?

It is confidently believed that those who will take such work in hand

and continue it intelligently and systematically through three years, on even small proportions of their ranges, will need no other arguments than the results themselves to induce them to adopt and pursue to the end like methods as to all of their run-down pasture lands.

HAY AND PASTURE PLANTS RECOMMENDED FOR CENTRAL TEXAS.

As the result of the experimental work conducted at Abilene, the following list of the grasses and forage plants that may be relied on as being well adapted to the climatic and soil conditions of central Texas has been prepared for the benefit of those who may desire to improve their ranges and are willing to undertake and prosecute the necessary work:

GRASSES.

BARNYARD GRASS (*Panicum crus-galli*).

This erect, leafy grass, known locally also as goose grass and sour grass, is found in nearly every State in the United States in barnyards and waste grounds and in very rich, moist soils. Where it has been studied it is recognized as having a definite value, both as a pasture and as a hay grass. In "Southern Forage Plants" (Farmers' Bulletin No. 2, United States Department of Agriculture) it is described as coarse and succulent, not easily cured into hay, quite valuable for soil-ing and for the silo, yielding heavily, and producing an unusual amount of seed. In some sections of Mississippi and Florida it is said to be a volunteer growth that makes a good hay, which is preferred to the best corn fodder by farmers who have thoroughly tested it. In Bulletin No. 87 of the Experiment Station of the Kansas State Agricultural College it is very favorably referred to as a forage grass. It first came into notice in central Texas about 1893, when it made its appearance in the cultivated fields or about old barnyard buildings in several of the counties. It grows in bunches 2 to 4 feet high and makes a great deal of fodder that is relished by cattle, both in its green state and when cured. It has many small roots that grow near the surface, and is a strong feeder. Seeds gathered near the station were sown, good stands were secured, and a vigorous growth was made. No difficulty was encountered in the efforts to cure it, and the hay, which was light for its bulk, was successfully baled. It is an annual, but readily reseeds itself. Of the several varieties now being cultivated in the United States, one known as Japanese barnyard millet was tested thoroughly in the station garden in 1899. The ground had been broken deeply in October, 1898, and seeds were sown March 15 following in thin hillside land. A good stand was secured, and by April 18 the ground was well covered. June 3 the grass was quite 3 feet high and an excellent yield was secured, and July 1 a second cutting was made. A third

cutting would have been secured had not the July drought of that year prevented. Tests made again fully confirmed the good opinion formed of the grass as the result of the former test. It will pay central Texas stockmen and farmers to cultivate the native and the improved varieties mentioned.

BERMUDA GRASS (*Cynodon dactylon*).

This creeping perennial grass is found in the United States from Pennsylvania southward to Florida and westward to Texas and California. It is not a native, but has been so long grown in Texas that it has become one of its distinctive grasses. It was introduced into southern Texas sixty to seventy years ago, near the mouth of the Brazos. From that beginning it has been taken to all parts of the State, and everywhere it has proved itself a valuable addition to the native grasses. It is propagated, in the main, by cutting up the roots or sod into small pieces, which are planted broadcast, or from 1 to 3 feet apart in shallow furrows. In central Texas it is extensively used for lawn purposes, as it makes a close and smooth sod. As even a moderate frost kills it down, it is not a very valuable winter grass; nor is it one of the best grasses for the high lands or prairies of central Texas, as its drought-resisting qualities are not strong. It is in this particular far inferior to curly mesquite or buffalo grass. If grown in low, moist places, it furnishes more and better grazing than either, and also produces an abundant crop of an excellent quality of hay. Several tests were made in the station grass garden to determine whether it could be propagated successfully by sowing seeds imported from the West Indies. Sowings were made in October, 1898, and in January, March, and April, 1899. Of the first two sowings not a seed germinated. A few of those sown in March germinated, but the plants soon disappeared. A rather thin stand was secured as a result of the April sowing, but when the August hot winds and dry weather came on, the roots began to give way, and by October 1 all were dead. As it is justly regarded as an excellent soil-binder, it was thought advisable to use it for strengthening the dams of the two station tanks, and in 1900 seeds were sown on the surface in March and raked in with a hand rake; but only a few plants appeared, and after a short time they disappeared. A few roots that were planted in April grew vigorously and soon made a close, compact sod. Central Texas stockmen will do well to establish Bermuda grass pastures, especially for their home calves and other stock, and if established in rich and moist soils, the most satisfactory results may be expected. As it is difficult to eradicate when once established, and spreads rapidly by means of numerous surface runners, it is not deemed advisable to locate pastures near lands intended for cultivation.

BUFFALO GRASS (*Bulbils dactyloides*).

This is a low, fine-leaved, and extensively creeping perennial, similar in its habit of growth to Bermuda. It is found in the dry prairies as well as in the river bottoms as far north as Minnesota, as far west as South Dakota, and east and south throughout many other States, including Colorado, Kansas, Arkansas, and Texas. It is a very common grass throughout central Texas, where it is often mistaken for grama grass. Liberally mixed with curly mesquite and needle grass, the combination makes an ideal pasture. It is not one of the richest fat-producing grasses, but being a native, peculiarly adapted to the conditions of soil and climate, and affording abundant pasturage, it is one of our most valuable species. It is in no sense a hay grass. It forms a beautiful, closely interwoven turf, with lateral, creeping root stalks which bear an abundance of leaves, but it never grows high enough to be cut. It can be grown readily from the seed, but owing to the manner in which its seeds are produced it is impracticable to gather them in quantities. As the grass is easily propagated by dividing the turf and sowing the bits in furrows, it is not difficult to get a good stand of it, and, as it will survive almost any degree of dry weather, of trampling, and other ill usage, it is deservedly one of the favorite grasses of the central Texas stockmen. Several tests were made with it on the station grounds to determine its true value. A few seeds were secured, and plantings were made in October, 1898. A fair stand was secured, and the young grass roots stood the drought of 1899 well. In 1900 roots were planted and not only lived, but grew well and spread rapidly, soon covering comparatively large spots in the grass garden and in the station pasture.

BUSHY BLUE STEM (*Andropogon nutans*).

In every county of central Texas this excellent hay grass may be found. It is a tall, rather coarse grass, which is cured with but little difficulty, makes a good hay that bales well, and in that shape has good keeping qualities. It was tested fully in the station grass garden with satisfactory results. Roots dug up where they grew in rocky places and also in the open prairie were put in the ground in the grass garden, grew readily, and demonstrated the value of this grass for quickly covering naked spots in pastures by transplanting the roots. Central Texas stockmen report that they have had satisfactory experiences with the same grass in the Dakotas and in the Territories of Arizona and New Mexico.

COLORADO GRASS (*Panicum texanum*).

The writer has met with and has known this grass many years, first in the valley of the Colorado, near Austin, Tex., later in Tom Green County, in the valley of the Concho, and more recently in several

counties of central Texas, including Taylor County. It is not certain where it originated, but it has been during many years past one of the best known and most valuable grasses in each of the several sections mentioned. In the Colorado Valley it made its appearance each year about the time the corn crop was ready to be laid by, when it would cover the fields, and the hay and grass would be almost as valuable as the corn crop. In the Abilene country (Taylor and adjoining counties) farmers regard it as by all odds the best hay grass. It produces large quantities of seeds that germinate well, and the growth of the grass in the late summer and early fall is astonishingly fast. Tests made in connection with the grass-garden work were in every way satisfactory.

It was clearly demonstrated that this grass is easily propagated from the seed, does not become a weed, makes a great deal of splendid hay that is readily cured, and keeps well either in bulk or in bales. It has much the habit of crab grass, but is coarser, and does not become a nuisance in the cultivated fields, as the crab grass often does. Then, too, it is easily gotten rid of on the farms, which can not be said of crab grass. As a hay grass it ranks with the very best throughout central Texas. (See fig. 2.)



FIG. 2.—Colorado grass (*Panicum texanum*).

COTTON TOP GRASS (*Panicum lochnanthum*).

This is not a very common grass in central Texas. It is to be found in all of the counties, but only here and there in cultivated fields. Only a few seeds were gathered, and they were sown in drills in the grass garden and germinated satisfactorily. The long dry spells in

1899 and 1900 operated much against the growth, but it grew fairly well. Under cultivation it did not develop as satisfactorily as did the few volunteer bunches that were not cultivated. The latter grew to be about 2 to 2½ feet high, the bunches were rather large, there was an abundance of leafage, the stems were not large or harsh, and the seed crop was fairly good. No difficulty was experienced in curing the grass, and the hay, though light, was excellent in quality and much relished by stock to which it was fed. It is a good hay grass for central Texas, but not equal in value to some others herein discussed.

CRAB GRASS (*Panicum sanguinale*).

Farmers of central Texas are divided in their opinion as to this grass. Some of them claim for it that it is very valuable both for pasturage and hay purposes, while others insist that it is more of a nuisance than a blessing, as it reseeds itself, makes its appearance in the cultivated fields before the crops are matured, and absorbs the moisture in the ground to an extent which prevents the best development of the cultivated crops. It is not necessary in this connection to go into the discussion of these differences of opinion. That crab grass does furnish a large quantity of good pasturage and a good quality of hay without cultivation is an undisputed fact, but it is a question whether it injures the cultivated crops more than it is worth to the farmer. As farmers throughout the semiarid regions are frequently short on stock food, and crab grass, as a rule, can be relied on to furnish a large quantity and a good quality of grass for pasturage purposes and for hay, there are sound reasons for the belief that it would pay central Texas stockmen and farmers to devote fields to this grass. A volunteer crop that grew on a neighboring farm was cut, cured and baled, and when the bales were opened several months later the hay was found to be sweet, and was greedily eaten by the cattle and horses to which it was fed.

CURLY MESQUITE (*Hilaria cenchroides*).

Ask average central Texas stockmen which are the best pasture grasses, and the chances are most of them will say curly mesquite, buffalo grass, and needle grass. It is a fact that when these stockmen are discussing their pastures, they are specially pleased if they can truthfully claim for them that these three grasses, in quantities, are to be found in them. The grama grasses are no less valued by them, but none of them are in sufficient quantities to make them such important factors in the make-up of the pastures as the others named. As between the curly mesquite and the buffalo grass, a large majority, it is believed, regard the former as being more valuable, all things considered. It commences to grow earlier in the spring than the buffalo grass, makes a thick, compact turf for summer grazing, matures on its roots, holds its own under almost any amount of rough treatment, such as trampling and heavy stocking, and continues green and growing when even the buffalo grass and the gramas show the effects of the long dry spells of weather that are characteristic of all the section. During such times the leaves and stems dry up and look dead, but after a warm rain they green out rapidly. Sods of curly mesquite were planted near sods of Bermuda grass to test their respective values as turf makers. As long as the rains came regularly the latter made a better growth than the former, but when the hot and dry weather

began, the curly mesquite held its own very much better than the Bermuda, and in midsummer clearly demonstrated its great superiority as a drought-resisting grass. As it is easily propagated from the roots, which, cut into bits, may be harrowed or heeled in the ground after the early spring rains, it is justly regarded as one of the best of all the native grasses of the section for use in renovating the ranges. As it never grows tall enough to be cut, it is suitable only for pasture. (See fig. 3.)

EVERLASTING GRASS (*Eriochloa punctata*).

This is the native grass that was the main reliance of cattlemen for hay in the early history of central Texas as a stock country. When old Fort Griffin, in Shackelford County, was a United States Army post, this grass was about all that the large number of cavalry and other horses there had to rely on for winter "roughness." In the seventies and eighties it grew all over the section from 2 to 4 feet high, in quantities sufficient to enable a great deal of an excellent quality of hay to be secured. Now it is a rare grass in the pastures, largely due to the fact that it will not flourish under such rough treatment as the ranges of the section received while "free grass" was the rule. In pastures not overstocked, along the fence rows,



FIG. 3.—Curly mesquite.

and at the ends of the rows in cultivated fields, it is now to be found in most of the central Texas counties, and always, under such conditions, the most permanent and promising grass in sight. As it makes a vigorous growth under favorable circumstances, and furnishes an abundant yield of a comparatively soft and very nutritious hay, it should be cultivated by stockmen and farmers. Seeds of this grass sufficient to sow a good plot of ground in the grass garden were saved, and in 1899 an excellent stand was secured that grew and developed vigorously and held its own remarkably well during the long dry spells of 1899 and 1900.

GAMA GRASS (*Tripsacum dactyloides*).

The writer, while making a field inspection of the central Texas ranges, looking up their native grasses and forage plants, discovered a few bunches only of a stout, coarse, branching perennial, and was much impressed with the idea of its probable value for pasture purposes. It was growing in large bunches from masses of stout roots, the stems and their broad leaves being numerous and from 4 to 6 feet high. During the year 1898 the bunches found growing in a low, rich, moist valley were watched with the view to securing seeds for tests in the grass garden. Abundant seed heads formed, but none of the seeds matured before the frosty autumn weather came on. Again, in 1899, the seed development was watched, and some seeds gathered, but, as in the year before, they were not matured. These facts seemed to demonstrate that the gama grass could not be propagated through seed grown in the section, and steps were taken to propagate it by use of the roots. A few of the large roots were dug up, cut into small bits, and planted in drills in the grass garden. This was in the autumn of 1899. Again, in the spring of 1900, other small roots were planted. In each case the root development was surprisingly great and quick. By the beginning of the autumn of 1900 the roots had largely multiplied and the stems were from 3 to 5 feet high. One planting was made on a rocky hillside, the other in low, flat, rich ground. The growth in the valley was more vigorous than that on the higher land, but the latter was strong and vigorous. The suggestion is made that central Texas stockmen and farmers can use this grass to excellent advantage in their efforts to improve their lowland pastures. From early spring till late in the autumn the leaves continue green. The stems are coarse and harsh, and the gama grass hay is not nearly as satisfactory as that of many other native grasses. The roots, however, penetrate deeply into the ground, and being very close, compact, and tough, the grass will stand much dry weather and rough pasturing.

GRAMA GRASSES.

For pasture purposes throughout central Texas curly mesquite is believed to be entitled to the first rank. Next follow, in the order named, buffalo grass and needle grass, and then come the three gramas that are native to the section. As to their relative merits it is not easy to decide. In the matter of quantity in central Texas blue grama and side oats grama are more abundant over a larger area than the black grama.

BLACK GRAMA (*Hilaria mutica*).

As far back as early in the eighties the Iatan Valley in Mitchell County was covered with a heavy growth of this grass. The stiff red soil seemed to be peculiarly favorable to its growth. All that section

was an open range, and free grass was the rule. Every year large quantities of this grass were cut and baled, and the hay was regarded as being excellent, though somewhat harsh. Since then the writer has found the same grass growing in other counties of central Texas, and quite as vigorously in the black-land valleys as in the red lands. In the immediate neighborhood of the grass station C. W. Merchant has two pastures kept as winter range for his white-faced thoroughbred cattle. The soil is a rather loose brown loam with a clay subsoil. The principal grass is the black grama, which grows abundantly and vigorously. A public road on the west side of one of these pastures separates it from the Parramore pasture, in which the surface soil is sandy. In this sandy land the black grama does not grow at all vigorously. Stockmen of the section agree in their statements that it will not grow well except in the heavier clay soils. At all events, the writer does not now recall a single pasture in all of central Texas in which it is growing to any decided extent, except where the soils are heavy, either red or black clay. Seeds were drilled and broadcasted in 1899 and again in 1900 in the grass garden, both in heavy and lighter soils. In each case a good stand was secured, but the best results were obtained from the plantings in the heavy soil. In central Texas this grass withstands the drought and bears pasturing very well. It grows tall enough for hay purposes, but as there are several better hay grasses that grow quite as well in the section, it is not recommended for hay. It is recommended, however, for pasture purposes. It is specially valuable for winter grazing, as the stems remain green long after the leaves have become brown, and to all appearances dead. As it is a perennial and seeds abundantly whenever there is rain in the early part of the year, it is valuable for the purpose of renovating worn-out or tramped-out native pastures.

BLUE GRAMA (*Bouteloua oligostachya*).

In every county in central Texas blue grama is to be found a native in the pastures, and yet it is not nearly so common as the stockmen would like to have it. There are two very closely related species, the other being known to agrostologists as *Bouteloua hirsuta*, the seed heads of which are darker than the former, really the only difference noticeable to the unscientific observer. Considering them as being practically the same, it may be said of them that they are not specially valuable as hay grasses. Though their stems are often tall enough to be cut, the leafage is neither heavy enough nor, as a rule, long enough for hay purposes. They grow well on the high arid plains and bench lands, and also in the lower and damper pasture lands. The blue grama is often confused in the minds of stockmen and farmers with buffalo grass, from which it differs in several important respects.

SIDE OATS GRAMA (*Bouteloua curtipendula*).

This is justly regarded by the well informed as one of the best of the native grasses of central Texas. It grows equally well in the uplands and lowlands, in pastures and in fallow lands. It produces a great many seeds that do not shatter badly, grows tall enough to be cut, and makes much fodder, which when cured is soft and much relished by stock, and it may be fairly classed with the recommended hay grasses. Its special value, however, is for grazing or pasture. It is a perennial, and is easily propagated from the seeds. Several tests were made of this variety in the grass garden. Some seeds were gathered on the range in the autumn of 1898 and were sown April 18, 1899. An excellent stand was secured, and the grass stood the drought of 1899 satisfactorily, and in 1900 made a splendid showing. In the spring of 1900 some seeds grown in the State of Washington and received from the Agrostologist were broadcasted on a high, rather dry level in the grass garden. A very good stand was secured, the grass grew vigorously, seeded well, and altogether gave satisfactory results. The same grass is known as "tall grama" and as "prairie oats" in some sections, in and out of Texas, but everywhere it is regarded as a valuable grass.

JOHNSON GRASS (*Andropogon halepensis*).

If Johnson grass happens to be mentioned in any crowd of stockmen and farmers in Texas, it is safe to conclude in advance that there will be much disputing in regard to it. There are farmers in central Texas, known to be successful, practical, sensible men, who insist that it is a very valuable grass and does not deserve the great amount of abuse heaped on it. On the other hand, many who are equally as favorably known declare it to be an unmitigated nuisance. Among stockmen there is about as much difference of opinion. Those who do no regular farming, but confine their farming operations to growing stock feed, say it is the very best all-around stuff they can grow. On the other hand, of those who are farmers as well as stockmen, many are pronounced in their opposition to it. None of the seeds were sown in the grass garden, but in the farms in the neighborhood are many fields seeded to it. Under ordinary circumstances it is a vigorous grass, growing 3 to 5 and often 6 feet high in the rich, moist valley land. Because of its rapid growth it frequently gives two to four cuttings yearly, the yield being from 3 to 5 and sometimes as much as 7 to 8 tons of hay, which, if cut when in full bloom, is rich, soft, and much relished by stock. Johnson grass is not recommended for cultivation by farmers, and is only recommended to stockmen who do not care to do farming further than to grow such stuffs as will make good rough stock feed.

KNOT GRASS (*Paspalum distichum*).

There is no difference of opinion among either the stockmen or the farmers of Texas as to this grass. All agree that it is one of the most valuable of all the native grasses of the section. It is to be found in low, moist soils throughout central Texas. Under suitable conditions its runners will often grow out from the roots 20 to 30 or more feet, and as they take root en route a single plant will furnish a large quantity of rich feed. It has a creeping habit of growth which rarely admits of its being cut for hay purposes. Several tests were made in the grass garden during the years 1898, 1899, and 1900. The seeds gathered in the neighborhood were sown in drills and broadcast in low, moist soils, and no difficulty was experienced in getting excellent stands. The roots were vigorous from the start and good growths of stems were secured, which rapidly covered the ground to considerable distances on every side. The habit of growth is similar to that of Bermuda grass, but knot grass is coarser, and in central Texas is the stronger grower of the two, and stands long periods of hot and dry weather very much better. No native grass of the section stands more rough treatment. On a farm not far from the station it was noticed by the writer that the horses and cattle in a pasture where it was growing in several low places kept it eaten down as close to the roots as possible, and yet the roots were strong and healthy. It can be propagated readily by sowing the seeds or by planting the roots, and would be very useful to cover naked spots in lowland pastures. It is a perennial and its local name is "eternity grass."

LITTLE BLUE STEM (*Andropogon scoparius* and *Andropogon torreyanus*).

These are two varieties of grass growing as natives throughout central Texas, each known locally as little blue-stem. The habit of growth is similar in the matter of roots, stems, and leaves, but the blooms and seed heads of the latter are more feathery; hence its other common name—feather edge or feather blue stem. The former seems to prefer the low lands, but is often to be found in the higher levels. The latter is a common grass on the high and dry prairies. It grows 2 to 3 and sometimes 4 feet high, in bunches, and in the early autumn matures an abundance of seed. When cut and cured it makes a soft hay, which cattle eat with relish. Tests made in the station garden showed that it is easily propagated from the seed. Under favorable conditions the roots spread and develop a fair sod. Both for pasture and hay purposes it is well worth the attention of central Texas stockmen and farmers.

THE MILLETS.

There are two of the wild millets growing pretty well throughout central Texas. Arizona millet (*Chenopodium macrostachya*) is to be found in every neighborhood, largely on the open prairies. "Wild millet" is to be found principally in the cultivated fields, and is

regarded as being a very troublesome weed. Both grow so well as to suggest that the soil and climatic conditions of the section are especially favorable to millets generally. They grow to a height of 18 to 30 inches, mature abundant crops of seed, produce much fodder, and make a light but very fair hay. A lot of the wild millet was baled on the station grounds in 1899 and 1900, and the bales, when opened after several months, were found to be in excellent condition. Encouraged by the success following the handling of these two wild varieties, several varieties of the "tame" millets were quite thoroughly tested. Seeds of German millet (*Chatochloa germanica*) were purchased in the open market and plantings were made in 1899 and in 1900. Hungarian millet was also carefully tested, as were the Japanese barnyard millet (*Panicum crus-galli*), a variety known as Shama millet (*Panicum frumentacum*), pearl millet (*Pennisetum spicatum*), and a variety of broom-corn millet (*Panicum milaceum*). Without going into particulars as to the results of these several tests, it may be stated generally that all of them were found to be well worth the attention of central Texas stockmen and farmers. The Hungarian did not grow so tall as the others, but quite high enough to be cut. March 15, 1899, seed of the Japanese barnyard millet were sown in thin land, on a hillside, and yielded heavily. In the efforts made to cure it it was found that it molded easily and had to be handled very carefully. Splendid stands of the Shama millet were secured from plantings of March 17 and April 10, 1899, and most excellent results were secured. No difficulty was experienced in the efforts made to cure it, and the hay that was baled was quite equal to the best hay grown in or imported into the section. Pearl millet seed sown April 18, 1899, turned out finely. The stalks grew to be 6 to 7 feet tall, with heads 8 to 10 inches long, which matured well. There was much fodder and the hay made from this millet was baled and fed to the stock, which ate it with relish. The broom-corn millet seed sown in April, 1900, gave most satisfactory results. The yield was large and the seed matured before July. There is no reason why central Texas stockmen and farmers, in years of ordinary seasons, should fail to have abundant supplies of hay for their live stock. They can hardly make a mistake in selecting any of the millets mentioned. If called on to recommend any one of them in preference to the others, the writer would find it difficult to decide between them. The tests made in the grass garden were in drills and also broadcast, but very little, if any, difference in the results was noticeable. For a crop of grain for seed purposes, perhaps drilling gives the better results.

NEEDLE GRASS (*Aristida fasciculata*).

As a winter and early spring grass, nothing on the central Texas ranges will take the place of this grass. To those who do not know

it it appears to be very much of a nuisance. The ripe seeds are sharp and sometimes pierce the tongues of cattle, and become fastened in the wool of sheep. As a rule cattle do not eat it when the seeds are ripe, especially when there is other grass, but after the needles fall they feed on the stems and leaves. Mixed with curly mesquite and buffalo grass in quantities and with fair proportions of the several varieties of the grama grasses, it helps to make a pasture which is all that reasonable stockmen and farmers could desire. It is among the first of the native pasture grasses to green out in the early spring, and all through an average winter in the section green shoots are to be found about the roots, which are protected by the cured stems that cling thereto. Its drought-resisting qualities are greater than almost any other native pasture grass. No other grass spreads so rapidly when given a chance to mature its seed. It is safe to say that it is about the earliest of all the pasture grasses, is as fattening as the best, is more generally distributed than any other, and more readily reseeds itself than the others, and hence contributes more than any other to the annual renewal of the range. The more of it there is on a central Texas cow ranch the more valuable the range. No special tests were deemed necessary to determine its general value, but roots were taken up and transplanted to determine whether it could be used to advantage in covering naked spots in pastures. The bunches so planted grew and developed satisfactorily. In order to determine how far it could be utilized in efforts to renew ranges, furrows were plowed from east to west across about 10 acres of station pasture land. This was done in early spring, when the seeds of the needle grass had matured and fallen to the ground. The prevailing south winds blew them by millions into and across these furrows, where they were caught by the soft plowed soil, and the following spring the furrows were well seeded to this grass. Elsewhere in this report the particulars of this experiment are given.

RESCUE GRASS (*Bromus unioloides*).

This is not a native grass of central Texas. Not until 1898 was it noticed by the writer in this section. Then he found it only in the court-house yard in Sweetwater, Nolan County, and along the reservation of the Texas and Pacific Railroad, which extends east to west across several central Texas counties. Stockmen in several counties stated that they had seen it occasionally in their sections, and in some neighborhoods it was reported in quantities sufficient to constitute a rather important factor in the make-up of the ranges. In 1899, and again in 1900, a few bunches were noticed in different parts of Taylor County, away from the railroad, and it is very probable that it will soon spread over that and the adjoining counties. It is believed that the first introduction was due to the seed falling from the moving

freight cars in which rescue-grass hay was being shipped. Some Oregon-grown seed received from the Agrostologist was sown in the grass garden May 4, 1899. An excellent stand was secured, but when the stalks were only 6 to 8 inches tall the seed heads began to form. At no time was the growth vigorous, and by October 1 the leaves were all dead, and the roots, though they survived the drought of that year, did not revive after the autumn rains began. Some seeds of the volunteer growth on the Texas and Pacific Railroad reservation were gathered in 1899 and were sown in the grass garden in the spring of 1900, but following the sowing late in May there was a dry spell and very few, if any, of them germinated, whether because of the dry weather or because the seeds were not fully matured when gathered was not determined. As no satisfactory tests of this grass were made in the course of the station work, and the only conclusions practicable are based on observations as to the volunteer growth referred to, no definite recommendation as to the grass for central Texas is ventured. It is the belief of the writer, however, that if well-matured seed be planted anywhere in the section, under normal conditions, rescue grass will prove a very valuable addition to the many excellent grasses, native and imported, known to do well in the section. Reports from other sections in and out of Texas show it to be a superior grass both for hay and pasture purposes. (See fig. 4.)



FIG. 4.—Rescue grass.

THE SEDGES (*Cyperus* and *Carex* spp.).

These are not, in fact, true grasses, but as they are distributed over a wide extent of country, including Central Texas, and in the early

spring furnish an abundant supply of fairly good green forage, they have a recognized value among stockmen.

SMOOTH BROME GRASS (*Bromus inermis*).

So much had been said officially and unofficially in favor of this grass that very earnest efforts were made in the grass garden in 1898, 1899, and 1900 to determine its adaptability to the climatic and soil conditions of central Texas. Seeds received from the Agrostologist were sown October 4 and November 15, 1898, and April 10, 1899. Those sown in the autumn germinated, but the grass did not survive the freezes of the following February. Those sown in April also germinated, a fair stand of grass was secured, and it lived through the hot and dry weather of July and August; but early in September it gave way, and the roots though alive did not revive after the autumn rains began. In the fall of 1899 a sowing was made early in November, but the rainfall in that month was only 0.24 inch, in December only 0.30 inch, and in January, 1901, only 0.03 inch, and practically no seeds put in the ground after October, 1900, germinated. It is said to withstand the severest drought and cold, and is highly recommended as an excellent pasture grass and as a second quality hay grass. The tests made as above at the grass and forage plant station did not give such results as justify recommending it for any purpose to central Texas stockmen and farmers. The probabilities are that under normal conditions it will do well in the section, and tests on a small scale may be made.

THE SORGHUMS.

Under this general head mention will be made of several tests made at the grass station. In addition to the varieties well known all over Texas, three not so well known were tested with gratifying results, namely, Jerusalem corn, Kafir corn, and milo maize. Plantings of seed of Jerusalem corn were made in April, May, and June, 1899, in low, moist land, on a gravelly hillside, and on higher, level, dry land. The seeds were sown in drills from east to west, beginning in the valley and ending on top of a rather rough hill. Excellent stands were secured, and the rainfall being good, the plants grew vigorously until about August 1. During August the precipitation was only 0.10 inch, only 0.44 inch during September, and nothing during October till about the 16th, when the precipitation was 0.01 inch. On October 26 the first rainfall of any consequence (2.09 inches) since June 30 occurred. During all these dry weeks the weather was extremely hot, with hot winds blowing nearly all day. That any of the forage plants revived is remarkable. The Jerusalem corn lived through the drought, and by November 1 had apparently taken a new lease on life, and continued to grow until a fair crop of seeds matured.

Kafir corn and milo maize have been grown in many neighborhoods through central Texas during the past six or seven years, and no tests were deemed necessary as part of the station work to determine their value as stock feed, but tests were made with the special view to determining whether the cured products could be baled successfully and advantageously. Seeds of both, some of them gotten from the Agrostologist and others in the open market, were sown in the grass garden in 1899 at the same dates the seeds of Jerusalem corn were sown. Some of the drills of each, where the stalks stood close together, were cut, cured, and baled. No difficulty was experienced in the efforts to cure them in shocks, but it was not practicable to make the bales very compact; hence the hay dried out considerably. The varieties of Kafir corn grown in the grass garden were the red and the black-hulled white. The former was a little in advance of the latter in maturing seeds, but the difference was trifling. Varieties of the sorghums mentioned above may be planted from April to July in central Texas, and under normal conditions will give two to three cuttings, and mature seeds during September.

Of the several varieties of the saccharine sorghums tested in the grass garden all were found to be fairly well adapted to the climatic and soil conditions of that section. No very material differences were noticeable in them. The tests were not made except to determine whether sorghum hay could be baled to advantage and be given a commercial value by putting it in convenient shape for shipping. The amber and orange are about the only varieties grown in central Texas, the former being somewhat earlier, the latter being regarded as about the best all-around cane.

In this connection it may be well to state that in the immediate vicinity of the grass garden several rows of corn were planted to determine the drought-resisting qualities of corn as compared with sorghum. The results of that test were very definite. The sorghums not only lived through the drought mentioned, but matured seeds satisfactorily. The corn, on the other hand, gave way under the influence of the hot winds and scant moisture and never revived. As to the value of the sorghums for forage purposes nothing need be stated in this connection beyond the general conclusions that they give more and better fodder than corn, and their matured seeds are very nearly as valuable as corn for purposes of sustaining and fattening stock.

TEXAS BLUE GRASS (*Poa arachnifera*).

This has been a well known and highly valued grass during many years past in many counties east and south of central Texas, but only during the past two or three years has it made its appearance as far north and west as Taylor County. In 1900 it was noticed by the writer growing in spots in several places in the county, and specimens taken

from the range were sent to him from Callahan, Jones, and Shackelford counties. In the spring of 1898 Prof. Jared G. Smith, of the Division of Agrostology, secured roots and seeds from Collins County and northern Texas and planted them in one of the station pastures. But the roots soon died under the influence of the long, hot, and dry summer of that year, and none of the seeds germinated. In the spring of 1899 seeds were broadcasted in the grass garden, on a small square of low, moist land. There was practically no rain thereafter for several weeks, and only a few seeds germinated and none of them lived. Again, in 1900, some seeds were sown in drills in the garden, but nothing like a good stand was secured, and the roots that lived into the summer were never vigorous. It is officially reported to be a winter-growing grass, and from November to May furnishes an abundance of luxuriant pasturage in sections such as northern Texas, suited to its best development. The tests made with it in connection with the station work were disappointing. It can be propagated satisfactorily by means of its roots, which may be divided into bits and planted 12 to 18 inches apart in moist fallow lands. It may be well for central Texas stockmen and farmers to use the roots for improving their winter pastures. (See Pl. I.)

WHITE TOP-GRASS (*Triodia albescens*).

This is an excellent hay grass for central Texas. It is to be found pretty generally throughout the section, principally in the lowlands, where it grows from 18 to 20 inches high and produces an abundance of soft stems and leaves. No special tests were made with it in the grass garden, as it is well known and needs no special commendation. It is easily propagated from the seeds, which may be gathered in the early autumn. It would pay those interested to cultivate it for hay purposes.

WILD RYE (*Elymus canadensis*).

This is by far the most valuable of all the first-class native hay grasses of central Texas, and since it is also a splendid pasture grass, it is only fair to say that it deserves the highest consideration at the hands of stockmen and farmers. In all the valley-land section it is found growing in rich soil near streams, but it will grow and do well on the higher levels. The writer's attention was first attracted to it by the fact that in the early part of June, 1899, when no other range grasses of the section had begun to green out, he found it 4 to 5 inches high in the valley of Indian Creek, in Taylor County. By arrangement with Mr. P. O. Forbus, on whose place the grass was growing, about an acre was cleared of brush and the former year's weeds, and the surface of the ground was broken with an iron-tooth harrow. By the opening of spring a splendid stand of this grass had been secured two to three weeks in advance of others in the neighborhood. By June 5



TEXAS BLUE GRASS, FROM PHOTOGRAPH OF SOD GROWN AT WASHINGTON, D. C.

it was high enough to be mowed, and a heavy crop of hay was secured. By July 3 a second crop was secured, the bundles measuring from 20 to 30 inches in length. A long, dry spell of very hot weather followed this second cutting, but the grass continued comparatively green and growing through it all, while the upland grass and the other valley grasses suffered very much. In November a third crop of hay was cut, which averaged about 15 inches in length. In the spring of 1900 the same spot was again cultivated with the iron-tooth harrow, together with about 2 acres more in the valley. Growing during the early spring and summer side by side with a splendid field of wheat on rich fallow land, the native perennial growth of wild rye held its own, standing very nearly if not quite as thick on the ground as the wheat, and growing much taller. Two crops of excellent hay were secured, the first after the seeds were fully formed, the second just before the second growth of seeds appeared. The grass was ricked, readily cured, and baled, and no hay grown in or imported into central Texas looked better, or in fact was better, than the wild-rye hay. A bale of the seeded hay and one that was not seeded were sent to the Division of Agrostology, Washington City, where it was pronounced to be of superior quality. Stock are exceptionally fond of the green grass as well as the hay. It is about the earliest pasture grass of central Texas, and may be relied on to continue green as far, if not farther, into the winter months than any of the native grasses of the section.

WILD TIMOTHY (*Muhlenbergia racemosa*).

This is not, in fact, a timothy grass, but in general appearance resembles it, and is known locally as wild timothy. It was found growing on Indian Creek, in Taylor County, in quantities, and later was found, a bunch here and there, in several other sections of central Texas, always in low, moist soils, and always vigorous looking. It grew 38 to 54 inches high and produced seeds and fodder abundantly. Seeds gathered in 1899 and sown in the grass garden gave satisfactory results. Enough of the grass as found growing on Indian Creek was cut and cured to make a fair-sized bale. This was opened and examined several months later (during February, 1901) and was found to be in good condition—quite equal to any of the baled grasses imported into central Texas. Farmers in Taylor and Eastland counties who know it well state that their stock prefer this grass to most of the others growing on their places. An acre of fairly rich moist land seeded down to wild timothy ought to produce, in a fair season, 2 to 3 tons of the best quality of hay.

OTHER CENTRAL TEXAS GRASSES.

In a general way it may be stated that throughout central Texas the variety of native grasses of substantial value is large, and if stock-

men and farmers of the section realized the possibilities of their ranges and meadows they would place higher money values on their properties. In a 400-acre winter pasture in Mitchell County, owned by Mr. B. Van Tuyl, the writer pointed out to the owner 56 different grasses and forage plants, all natives. In addition to the native grasses above enumerated, others well worth the consideration of central Texas stockmen and farmers might be noted, but it is believed that a sufficient number have been mentioned to demonstrate to those most interested the very great possibilities of the section for live-stock purposes.

It may be well also to mention that while a fair proportion of the grasses not natives tested in the grass garden were found to be valuable for the section, and well worth the consideration of stockmen and farmers, a large number were found to be entirely unsuited to its climate and soil conditions.

LEGUMES IN CENTRAL TEXAS.

Among the most interesting of the experiments made in the grass garden were those with several varieties of alfalfa, beggarweeds, butterfly pea, the clovers, the cowpeas, the Canada field pea, gram or chick pea, the Metcalfe bean, soy bean, sulla, sanfoin, Texas pea, velvet bean, the vetches, and a native wild bean that specially attracted the attention of the writer. These experiments clearly demonstrated that the climate and soils of central Texas are favorable to the growth and best development of a larger number of the legumes than had previously been supposed. The following notes cover the most important tests.

ALFALFA OR LUCERN (*Medicago sativa*).

During the several years immediately preceding the establishment of the grass and forage station (in 1898) farmers of central Texas experimented with the common alfalfa. The writer visited several farms in the section where tests had been and were being made, but as they were on irrigated farms and the station work was instituted and conducted distinctly to determine what grasses and forage plants could be grown successfully in the section without irrigation, no further mention of them need be made here. Special mention will be made, however, in this connection of tests made near Merkel, in Taylor County, Tex., by Major Garote, a retired United States Army officer, who is devoting much attention to developing the resources of the section as a grass and fruit country. About 1895 he sowed lucern in sandy land, and had no difficulty in securing a good stand. The growth was satisfactory, but was kept eaten down by rabbits, which swarmed into his alfalfa patch. After trying during two years to grow the crop faster than the rabbits could eat it down, he abandoned the project and plowed up the roots, except those near a fence row,

and he left those undisturbed only because he could not get at them conveniently with the plow. In 1898 the roots left developed astonishingly, and in 1899 the stalks were too large and too tough to suffer seriously on account of the rabbits. In 1900, when the writer visited the Garote farm, he found the alfalfa growing as vigorously as any one could reasonably wish without any cultivation at all. Bunches, each one of which would have furnished a good sized bundle, were examined, some of them 24 to 36 inches high, and the stalks were well leaved and full of blossoms and seeds. In March, 1898, Prof. Jared G. Smith sowed a plot of the station grass garden with lucern on freshly broken sod. A rather thin stand was secured, and the drought of that year was very hard on it. In the autumn following the roots that survived began a vigorous growth, but the most of them were destroyed by prairie dogs and rabbits, which congregated on the alfalfa plot from far and near. In October, 1898, the plot was plowed deep and a surprising number of roots were found still alive. The following spring (1899) they made a vigorous growth, and a small plot (about 25 by 25 feet) on which there was a satisfactory stand was set apart for further tests. In the meantime the garden had been fenced in with woven wire and the prairie dogs and rabbits shut out. By June the stalks were 18 to 27 inches high, and a first cutting was made; July 2 a second cutting was made, many of the stalks measuring 24 to 28 inches; July 22 a third crop was ready for cutting, some of the stems measuring 18 to 20 inches in length. From November 1 to July there was abundant rainfall for the section and season. The alfalfa on this spot made a splendid growth in 1899 and in 1900, and in March, 1901, when the station was turned over to its owner, there were roots growing from 3 to 5 feet down into the heavy soil nearly as strong and vigorous apparently as in the Garote farm of lighter sandy soil. In 1899 (April 25) alfalfa seeds were sown in the garden in drills. Good stands were secured, and the growth was satisfactory up to about June 20, by which time there was a severe drought. By August 1 the foliage was dried up, and even the roots appeared to be dead or dying. October 26 a good rain fell, and in a few days green leaves had started from the roots, and by the beginning of winter (December 1) the new growth was 8 to 10 inches high. During November there were several frosts, but the alfalfa continued green through the winter.

TURKESTAN ALFALFA (*Medicago sativa* var. *turkestanica*).

In April, 1899, seeds of alfalfa from Bokhara, Tashkend, and Samarkand—all in Russian Turkestan—were sown in the grass garden in drills. About the same time seeds of the common lucern were also sown in the garden. The Turkestan variety came up quite as well as the other, and quite as good a stand was secured. The drought of

that year was protracted and very severe, and both varieties suffered greatly—the common lucern more than the other. By August the plants began to fail, and by September the roots looked to be dead or dying. Immediately following the October rains noted above the roots revived, and by the middle of November a vigorous growth of new foliage had been made, and continued green through the winter.

OASIS ALFALFA.

Three plantings of seeds of Oasis alfalfa from Tunis were made in the grass garden during 1899. The first, in February, did not give good results. On account of several frosts the seeds failed to germinate. In April seeds were sown in two plots, one in low and rather damp soil, the other on higher and dryer land. Excellent stands were secured and the growth was vigorous from the start. By July 30 the drought was on and the plants were looking wilted. By August 1 the leaves had fallen off and the roots appeared to be dead. Immediately following rain on October 26, the roots began to put out new foliage, which by November 15 was 8 to 12 inches tall. By December, in spite of the frosts of November, the plot was green, and continued so during the winter. The following spring (1900) both plots developed satisfactorily in spite of the long dry and hot spell of that year, stood up well, and went through the autumn and winter in good shape. In March, 1901, when the station was turned over to the owner, this variety was looking more vigorous than either of the others.

As the result of these several experiments with alfalfa it appears reasonably certain (1) that all the varieties named can be grown successfully without irrigation in central Texas; (2) that during seasons when the rainfall is abundant the common alfalfa or lucern will do better than the Turkestan varieties, and they rather better than the oasis alfalfa; (3) that during the long dry spells that are frequently to be expected throughout the section the oasis alfalfa will hold its own better than the Turkestan varieties, and they better than the common lucern; (4) that sandy soils are better for lucern than the heavier soils, as they hold moisture longer.

FLORIDA BEGGARWEED (*Desmodium tortuosum*).

Seeds of this plant were secured direct from Florida and sown in the grass garden. An excellent stand was secured. The plants grew vigorously, and notwithstanding the ground was upland, very rocky, and very thin, the growth was larger than desired; that is to say, the plants developed into bushes from 4 to 6 feet tall, the stems being woody and altogether too coarse for hay purposes. As the leaves shed easily, unless the plants are grown very thick on the ground to insure the stems being small, it will not be practicable to bale the hay. If grown so that it can be baled to advantage, a great abundance of

superior feed for stock can be grown on a few acres, as the foliage and seeds are rich in the best hay properties. As a renovator of worn-out soils or as a green manure nothing better can be recommended. Stockmen and farmers will do well to familiarize themselves with the beggarweed. It is confidently believed that in years of normal rainfall in central Texas 8 to 10 tons can be grown to the acre on rich valley lands. In the southern States large crops of it are grown after crops of oats are harvested. For ensilage purposes it is known to have a very definite value.

THE CLOVERS.

Outside of the grass and forage plant station very few efforts have been made in central Texas to grow any of the clovers, and yet it is a fact that some of them can be grown to advantage. During 1898 seeds of several varieties were sown in the grass garden. Prairie clover (*Kuhnistera*), common throughout the prairie region, produces on the range a fair amount of very good forage, which is relished by stock. It is not believed that it would pay to cultivate it.

ALSIKE CLOVER (*Trifolium hybridum*).

In 1900 (March 10) several rows of this clover were planted in the grass garden. A very good stand was secured and the plants grew nicely. During the hot and dry month of June they suffered very much, but revived after the normal rainfall during July. In August they again had a wilted look, but the roots survived, and by September 5 were growing again. During September the rainfall was exceptionally large (9.65 inches) and by October the plants had made a satisfactory growth. October was a seasonable month and the development was good. There was but little rainfall during November, December, and January (1901) (0.24, 0.30, and 0.03 inch, respectively). During February, 1901, the precipitation was only 1.44 inches. The shortage was rather serious during March, being only 0.72 inch. During November there was considerable frost. In December, January, and February, there was decided winter—frequent killing frosts. March was also a cold month. These conditions were hard on the plants, which had not had a fair chance to form strong roots. Early in December they began to fail, and by March were to all appearances badly damaged. However, when the station lease expired (March 19) and the station was given up to the owner practically every root of the alsike clover had begun to put out new shoots.

BUR CLOVER (*Medicago maculata*, *Medicago denticulata*).

In 1898 the writer found the variety first mentioned growing in Mitchell County near Colorado City. In all probability the seeds were brought from California in the wool of sheep which had been

shipped into the county from that State in large numbers from 1883 to 1887. It was growing vigorously, but not in quantities sufficient to make it anything of a factor in the matter of forage supply. In the spring of 1899 seeds of the latter variety were sown in the grass garden. Only a few germinated, hence only a few bunches were secured. They grew well and remained green till August. The drought of that year destroyed most of the roots. In December those that survived greened out nicely and went into the spring of 1900 in good shape. The runners grew to be $3\frac{1}{2}$ to 4 feet long and the leafage was exceptionally good. In the spring of 1900 other seeds were sown, but in a rather cloddy soil, and none of them germinated. Here lies the only serious difficulty in the matter of growing bur clover in central Texas—it is very difficult to secure good stands. Nothing tested in the grass garden showed better drought-resisting qualities, and it is believed that a good stand once secured (which is quite possible, though difficult) will yield satisfactory results. It is liable, however, to be winterkilled, and to this extent is not regarded as a very certain forage crop. The writer studied the bur clover in California pastures, and as the result of his observations and personal experiences with it can recommend that it be further tested in central Texas. It is believed that the best time for sowing the seeds in this section is in the autumn months, say during October and as late as November.

MAMMOTH CLOVER (*Trifolium medium*).

It was believed that this variety, known also as sapling clover, would do better in central Texas than the common red clover, which it much resembles, as its habit of growth is more vigorous as a rule. A few seeds were sown broadcast in the grass garden in 1899, but an indifferent stand was secured and the few plants were much crowded and injured by weeds, and most of them were killed in the efforts to destroy the weeds. The growth was never vigorous, and when the drought came on every plant died. March 20 a plot of the grass garden was planted with seeds of this variety, in drills. A good stand was secured which was afterwards reduced by cutworms. The plants left went through the summer very well, but many of the roots were winterkilled. Those that survived greened out in the spring of 1901, and on March 19 were growing and developing satisfactorily. As this single test of the variety was very inconclusive in results, the only suggestion ventured is that further tests should be made, the probability being that it will be found to be fairly well adapted to local conditions.

RED CLOVER (*Trifolium pratense*).

The efforts made to grow red clover in the grass garden were mostly failures. In April, 1899, two plantings were made, broadcast, one in low and moist, the other in higher and drier, soil. Excellent stands

were secured and the plants grew vigorously and promised satisfactory results. The weed growth of the season was heavy and many of the clover roots were choked. Early in May, in spite of this difficulty, the plants were 8 to 16 inches high and continued green through June and until late in July. The latter part of July and the early days of August were exceptionally hot, even for this section. By September very few of the roots were alive, and none of them survived the winter.

January 19, 1901, seeds of red clover were drilled in the grass garden with wheat, on the presumption that as a nurse crop the wheat would protect the young roots through the winter and spring and enable them to enter the summer with a strong root development. Only a few of the seeds germinated, however, and they were never vigorous. A few seeds were drilled in the garden March 20, 1900. They germinated very satisfactorily, but the plants were never very strong. They survived during the hot and dry summer months, but most of them were winterkilled.

RUSSIAN RED CLOVER (*Trifolium pratense* var. *pallida*).

Only one test was made of this variety in the grass garden. March 20 seeds were drilled, a good stand was secured, and the plants grew well. They went through the hot and dry months fairly well and made a satisfactory growth, but many of them were winterkilled. March 19 the roots had greened out well. Altogether, the variety seems better adapted to local conditions than the common red clover, but the results of the tests do not justify more than a general suggestion that it should be given further tests, with the probabilities in favor of good results.

SWEET CLOVER (*Melilotus alba*).

Of all the clovers tested in the course of the station work near Abilene, none gave nearly such satisfactory results as this variety. Only one test was made, and that under conditions far from favorable, yet the results were eminently satisfactory. Seeds were drilled in low, rather moist, fertile soil, March 18, and apparently every seed germinated quickly. The stand secured was all that could have been wished for. From the start the plants grew vigorously and were soon quite 2 feet high on an average, and a fair crop of seeds was matured. In one row, near the banks of the water hole in which water stood the greater part of the spring and into the early summer, the growth was very strong. Many of the plants measured $3\frac{1}{2}$ to 4 feet high. The leafage of all the plants in the garden was heavy and a fair crop of seeds was matured. During the hot and dry weather of June, July, and August the plants suffered, many of the leaves falling off. The month of September was hot, but the rainfall was exceptionally heavy, and under such influences the sweet clover revived and went into the

winter in vigorous condition. It suffered little, if any, on account of the frosts of December, 1900, and January and February, 1901. March, 1901, was a cold month for central Texas, but every root of the sweet clover on March 19, when the station work closed, was alive and vigorous. No effort was made to convert the green growth into hay. Had the plants been cut when young and tender, doubtless a good quality of fairly soft hay could have been secured. The cutting, however, was done when they were 2 to 3 feet high and the stems were woody. A couple of bales of the hay were made, one of which was given to Mr. P. O. Forbus (foreman of the station working force), who placed it in his own barn, where it perfumed his entire hay crop. The other bale, made in the summer of 1900, was opened in April, 1901, and fed to a horse and a cow. The horse ate a part of it, without much relish, but the cow greedily ate the balance. Several tests have been made of the sweet clover in the Abilene country, in every case with satisfactory results. Mr. F. C. Digby-Roberts, now mayor of Abilene, saved it for his honeybees, and was much pleased with the results. Others tested it as a green forage crop. They found that cattle and horses did not relish it much at first, but as it was green before anything else on the range, they soon took kindly to it and ate it readily. Some roots of this clover dug up in the grass garden and sent to the Division of Agrostology, Washington, D. C., were surprisingly long and large. It is deemed safe to recommend sweet clover for green forage and hay purposes to central Texas stockmen and farmers.

WHITE CLOVER (*Trifolium repens*).

The tests made in the grass garden with this variety were not satisfactory. Seeds were sown broadcast in the spring of 1899, and a thin stand only was secured. At no time were the plants vigorous. During the summer most of the roots died, and those that survived were winterkilled. November 13, 1900, seeds were drilled, but only in low, moist, fertile soil. Very few of them germinated. The few roots secured did not grow well and most of them did not survive the hot and dry summer months. During the succeeding winter every root left was killed. As at its best this variety produces but a small quantity of green forage or hay, it is not recommended to central Texas stockmen or farmers.

PEAS AND BEANS.

COWPEA (*Vigna catjang*).

During the season of 1899 about sixteen varieties of cowpeas were tested. In every case the results were satisfactory. The seeds were planted in drills 3 feet apart, and as long as the season permitted the ground was kept stirred between the rows and about the roots. The plantings were all made the same day—April 11. Good stands were

secured, the plants grew well from the start, and all of them matured seeds in spite of the very-unfavorable season. Early in August it was seen that the vines were suffering and shedding their leaves. Most of them were cut, cured, and baled, and a comparatively large quantity of an excellent quality of hay was saved, and through the following winter was fed to and greedily eaten by cattle. Some of the vines were cut with their fully formed but unripe fruit pods attached. These pods cured readily with the stems and leaves and added no little to the fattening value of the hay. Some seeds of each variety were saved and planted in the spring of 1900. The general results were about the same as were secured in the former season. It is difficult to determine as to the relative values of the many varieties tested, as all of them were satisfactory. It is well known that the cowpea as a soiling crop is one of the best. As it produces in abundance fruit rich in all the special elements of a first-class stock feed, it is highly valued by those who know it best. The green-vine product is one of the richest of stock foods, and when cured is a very valuable hay. Central Texas stockmen and farmers are earnestly recommended to sow considerable areas of their farms each year to cowpeas. They can hardly make a mistake in the matter of variety.

FIELD PEA.

A few seeds of the Canada field pea were planted April 10, 1899, in the grass garden. Only a poor stand was secured, but the vines grew well, with a great deal of stem that was covered with leaves, bloomed well, and matured abundantly. They had practically run their course before the hot and dry summer winds commenced. The vines and seeds are very similar in appearance to the well-known English or garden pea. In the early spring of 1900 some of the peas saved from the crop of 1899 were sown in drills 3 feet apart, very thick in the rows, the purpose being to test the value of this variety for forage purposes. An excellent stand was secured, and the vines grew luxuriantly and fruited satisfactorily. When the pods were fully formed, but before the peas were ripe, the vines were cut, cured without difficulty, with the seed pods attached, and baled. The bales were examined during the winter following and the hay fed to a horse and a cow, each of which ate it with relish. Some of the vines and seed pods were fed green to cattle and a horse and were eaten with relish by all. As this variety of pea will produce an abundant and early crop for forage or seed, it will pay those having stock to feed to cultivate it.

GRAM OR CHICK PEA (*Cicer arietinum*).

This is a curious-looking plant, but little known in this country, though it has been cultivated in Asia Minor during the past thirty

centuries, its seeds being highly valued as a cattle food and as an article of human diet. The plant itself, however, is unsuited for green forage, as it is covered with a clammy exudation consisting largely of oxalic acid. A few of the peas were drilled in the grass garden and practically every one of them germinated. The plants quickly grew to a height of 18 to 20 inches and matured an excellent crop of seeds.

METCALF BEAN (*Phaseolus retusus*).

The writer hesitates to express an opinion as to the merits of this perennial legume. It had been represented to him as being a very valuable native of western Texas and New Mexico, with large drought-resistant qualities, and he was anxious to give it every advantage in the matter of cultivation. A few seeds were received from the Division of Agrostology and a few from Mr. James K. Metcalf, of Silver City, N. Mex., who was the first to introduce the plant into cultivation several years ago. Plantings were made March 21, April 11, and March 18, 1899. Good stands were secured, and the vines quickly grew to be from 8 to 12 feet long, spreading out in every direction from the crown of the root, much like sweet-potato vines. In fact the vine growth was remarkably strong, but not a blossom appeared. Early in August the vines began to languish under the hot and dry weather, and by September 1 all the roots were dead. As the result of correspondence with Mr. Metcalf, and at his suggestion, they were planted in 1900 in rows 8 feet apart in hills every 8 to 10 feet. As in 1899, a good stand of strong vines was secured, and very late in the fall a few blossoms formed, but too late even to develop into pods. Finding that there would be no bean crop, most of the vines were cut; some were feed green to cattle and were eaten readily by them, and some were cured and baled. The bales were opened in February and March, 1901, and the hay fed to a horse, which ate it with evident enjoyment. As the result of these experiments, extending through the seasons, one very dry and the other (1900) a very favorable one, the conclusion was reached that for hay and soiling purposes the Metcalf bean is good in central Texas, but the seasons are not long enough to insure a bean crop.

SOY BEAN (*Glycine hispida*).

This is one of the oldest cultivated forage plants. It has been grown in China and Japan for many centuries, but was introduced into this country only a few years ago. The seeds are very rich in fats and nitrogenous compounds, and it is claimed that next to the peanut it is the richest of all the legumes in the digestibility of its food constituents. Three varieties were tested in 1899 in the station garden. The early variety grew from 8 to 12 inches, and the yield of

seeds was satisfactory. The medium variety grew to be about as tall as the early variety and produced a very abundant crop of seeds. The late variety grew to be about 24 to 30 inches high, but matured only a few seeds. In 1900 seeds saved in 1899 were planted. The results were about as in the previous year, except that the vine growth was stronger, due to the fact that the season was in every way more favorable. The bean yield of the early and medium varieties was large, but that of the late variety was practically nothing. Many pods of the



FIG. 5.—Soy bean.

last formed, but the beans did not mature before the frosts caught them. When cut before the pods are ripe the cured product becomes a very rich and in every way superior stock food. Too much can hardly be said in favor of this valuable forage plant, and, as it is as easily grown in central Texas as cornfield black-eyed peas, and the ripe bean is among the richest of concentrated foods, it should be largely cultivated by those having stock to feed. (See fig. 5.)

SULLA (*Hedysarum coronarium*).

This is another of the perennial legumes that is well worth the consideration of central Texas stockmen and farmers. It has been extensively cultivated in southern Italy, where it is a native, upward of two hundred and fifty years, and was introduced into this country but a few years ago. Seeds received from the Division of Agrostology were sown in the station garden May 4, 1899, on the side of a dry, gravelly hill. The stand secured was satisfactory, and by July 15 the plants were 6 to 12 inches high, and the roots had grown down into the ground to corresponding depths. About that time, as the result of the very severe drought of that year, the plants began to give way, and by September were apparently dead. October 26 the heavy autumn rains began and they revived at once, and by November 10 a new growth of plants 3 to 6 inches high had been made. They continued to grow until December, and in January, 1900, the crowns of the roots were still green. In February they gave way as the result of the heavy frosts. The plant growth was vigorous, and late in the season the plants, which were from 18 to 24 and in a few instances 30 inches high, were covered with a rich crimson flower that was showy and beautiful. No seeds matured, however. As to its feeding qualities, it compares favorably with the best of the clovers and alfalfas and, in central Texas, produces satisfactory crops.

VELVET BEAN (*Mucuna utilis*).

This legume is attracting a great deal of attention, especially in the extreme Southern States, where the soil and climate seem to be specially favorable to its development. In central Texas it is a valuable forage plant, but too far north for it to mature seeds satisfactorily. It was carefully and thoroughly tested in the station garden in 1899 and 1900, and the results each year were practically the same. The vine growth was phenomenally strong, and while there was a profusion of blossoms, and in 1900 a considerable seed-pod formation, not one matured bean was secured. The vines proved to possess abundant drought-resistant qualities, and, in fact, withstood the hot, dry weather during both summers into August better than anything grown in the station garden, except possibly the soy bean. In 1900 the seasons were more favorable than in the preceding year and the vines continued green well into October. Some of the vines grew to be 15 to 20 feet long, with a heavy leafage. In the latter part of September, 1900, several rows were cut, and the vines were cured and baled. The bales of the cured product kept sweet, and were fed to stock in January and February, 1901. It is confidently believed that it may pay those having live stock to be wintered to cultivate velvet bean, not only for green forage, but for its hay value, as far north as central Texas. (See Pl. II, fig. 2.)



FIG. 1.—RANGE NEAR ABILENE, WHERE THE EXPERIMENTS WERE CONDUCTED, SHOWING CHARACTERISTIC GROWTH OF MESQUITE BEAN.



FIG. 2.—GROWTH OF VELVET BEAN.

VETCHES.

Comparatively few stockmen and farmers of central Texas know anything about the vetches, and yet more than one variety, natives to the section, are growing on the ranges and in their fields, and constitute factors of no small importance in the make-up of their pastures.

SPRING VETCH (*Vicia sativa*).

Seeds of this variety were tested in the station garden in 1899. A first planting was made in February, but on account of the ground being cold, and continuing so until in March, few seeds germinated. Later plantings were made March 17 and April 10, good stands were secured, and the plants grew rapidly to 18 to 20 inches in length, and matured good crops of seed. A cutting could have been made during June and early in July.

HAIRY VETCH (*Vicia villosa*).

This variety was also tested in the station garden in 1899, the plantings being the same dates as those of the spring vetch. The results were substantially the same with both varieties. A cutting of the hairy vetch was cured and baled. The hay was soft and rich, and the yield (estimated) was at the rate of $1\frac{1}{4}$ to $1\frac{1}{2}$ tons per acre. The soil where it grew was not rich. The nutritive value of the hay is very high. As in fertile soils from 2 to 4 tons per acre can be grown, it will pay those having live stock to feed to cultivate it, and also the spring vetch.

OTHER FORAGE PLANTS.

With a view to determine the value of several of the grain crops generally grown in central Texas, especially for forage and hay purposes, a number of interesting tests were made with more or less satisfactory results.

COMMON OATS AND WHEAT.

It is a well-known fact that when oats are cut just after heading they make hay of the finest quality. It is also a well-known fact that a crop can be grown in central Texas during the winter on ground from which corn has been gathered, and can be harvested in time for planting the ground in the spring. It is further known that during the years when the rainfall is normal large yields (3 to 5 tons per acre) of the straw can be grown on the fertile lands of this section. The pressing needs among stockmen and farmers are for early spring pastures and for plants that will yield, under wider cultivation, good hay crops. The time has passed for any class of live stock to be left to "rustle" on the range for their winter feed. The enterprising stockgrower now recognizes the necessity for providing winter forage

for his stock, both as a matter of business and as a matter of humanity. With a view to assisting stockmen of central Texas and farmers in their efforts in the direction indicated, the writer made a large number of tests in the station garden during 1900 to determine the value of oats and wheat for hay and green forage purposes. He secured many different varieties from the Department of Agriculture and from other sources, planted the seeds in drills, cultivated the ground thoroughly, had the crop cut and cured when the seeds were in dough state, and baled the hay product. The results were in every way successful. The seasons were favorable; the yield in every case was considerable; the hay had a rich color, and in the bales presented an attractive appearance and kept as well as any other hay. During the following winter the bales were opened and fed to stock and every straw of it was greedily eaten. Mr. P. O. Forbus, foreman of the station working force, has grown during the last two or three years a turf oats which has not only afforded a good winter pasture for his stock, but has yielded fairly good grain crops later. He has not cut the crop for hay, but is satisfied, as the result of the station experiment of 1900, that in that shape the crop will be worth much more to him than as a grain crop. Mr. W. J. Warder, late a stockman and farmer of California, still later of the Abilene country, and now at El Paso, Tex., is authority for the statement that several years ago in California, realizing that the drought coming on was likely to ruin his wheat crop, he had the entire field cut just after the heading. He handled the green product precisely as if it had been grass, had no difficulty in curing it, and sold the hay product for more than he could have realized for a good grain crop. Mr. C. W. Merchant, of Abilene, Tex., is making a specialty of cultivating both oats and wheat expressly for green winter forage and only incidentally with a view to grain crops. Central Texas stockmen and farmers are reasonably certain, four out of every five years, to secure a good oats-hay crop, even if they shall fail to secure a good grain crop. A wheat crop for hay purposes is not quite so reliable, but is worth the annual effort, and the writer strongly recommends that such be made.

PEANUTS (*Arachis hypogæa*).

As above suggested, reliable forage plants which can be converted into good hay are what is much needed by stockmen and farmers in central Texas counties. They are reasonably certain each year to have grass for their live stock from the time the earliest range grasses (as needle grass) begin to green out, well into the early winter. After the range grasses are frost-bitten, however, they are often troubled to procure winter feed for stock without having to pay ruinous prices. It will pay them to go into the work of experimenting in the direction indicated with a view to helping themselves out. They can supply

themselves, certainly, abundantly, and reasonably as far as cost is concerned. The question is, Will they take the trouble? Many of them will be surprised when informed that the well-known peanut is one of the most valuable fodder plants for this section of Texas. They may safely use either one of the two very distinct varieties, "common," which produces the peanut of commerce, or the "Spanish." It may also surprise them to be told that peanut-vine hay is about as nutritious as red clover and richer than timothy, and that peanut meal makes a richer stock food than cotton-seed meal. Yet these are facts. Several tests were made in the station garden in 1900 to determine how peanut hay could be utilized to the best advantage. Seeds of both of the varieties were secured and planted in rows so as to admit of cultivating the soil. Being dry, rather sandy upland, good stands and good yields of both vines and nuts were secured. The Spanish variety gave the better results so far as the quantity of vines was concerned; but the common variety gave a better yield of fruit. When the pods were about half grown the vines were pulled up, turned with the nuts to the sun, allowed to cure, and when cured, were thrown into shocks, and later made into bales. Several months thereafter the baled products were examined and vines and nuts found to be sweet, and when fed to cattle, every stem, leaf, and nut was eaten. For the benefit of those who may care to look into the subject, it is recommended that they send to the Department of Agriculture for Farmers' Bulletin No. 25, Peanuts: Culture and Uses; study it carefully, and then put in good-sized fields of peanuts, not for the matured peanuts, but solely with the view to using the vines and half-green nuts for forage purposes. It will pay well in years when there is a normal amount of rainfall.

RAPE (*Brassica napus*).

This succulent and nutritious forage plant, which is closely related to the Swede turnip, can be easily and profitably grown in the deep, rich, warm loams and sandy soils to be found in all the counties of central Texas. It makes an excellent feed for either cattle or sheep, and will stand a great deal of hot and dry weather. Of the several varieties that are well known in the United States and Canada, the Dwarf Essex is the most widely cultivated. Seeds of this variety were sown April 18, 1899, in the grass garden, in low, rather moist, but not very fertile soil. A good stand was secured and the plants grew vigorously, but they were attacked by prairie dogs and jack rabbits before the garden could be closed in with wire netting, and not a plant was saved. In 1900 plantings were made March 19 and 26 in the same kind of soil, and a good stand secured. The plants quickly grew 12 to 24 inches high, and when other things were suffering during the summer on account of the hot and dry winds, the rape plants held their own surprisingly well.

SALTBUSHES (*Atriplex*).

The several tests made of this forage plant in the station garden have been entirely satisfactory. Seeds of several varieties were planted March 16 and April 18, 1899, but only a few of them germinated. Of Nelson's saltbush (*Atriplex pabularis*) and of Nuttall's saltbush (*A. nuttallii*) a few plants each were secured. About a dozen weak plants of the shad scale (*A. canescens*) started, but they soon died. Of all the varieties tested, the annual saltbush from Australia (*A. holocarpa*) gave the best results. The growth was not large, being only from 12 to 24 inches high, but the seed development was surprisingly great. Seeds of all the varieties named, except the shad scale, formed and matured through the long and hot summer; not a few, but thousands of them. Twice in July and August the seeds were carefully stripped from the plants, but as fast as the earlier seeds were gathered others grew and developed, ripened, and fell off, covering the ground under each bush. The plants continued green until early in December, but by the 15th of the month, as the result of some rather severe frosts and freezes, they were nearly all dead. In 1900, each of the above-named varieties was again tested and the tests confirmed in the mind of the writer the opinions formed of them the season before. Seeds of the Australian saltbush (*Atriplex semibaccata*) were received from the Division of Agrostology and were sown both in March and April. The previous year the seeds had been planted rather deep, and it is believed that the thin stands were in consequence thereof. In 1900 the seeds of the variety under special consideration were sown in shallow drills and were lightly covered. An excellent stand was the result, and the plants were vigorous from the start. As this is a procumbent or prostrate variety, it will be better to refer to its vines, rather than to its plants. They spread out in every direction from the crowns of the roots, from 2 to 4 feet, and produced an abundant leafage and a large number of seeds. Specimen plants, the roots of which were about 2 feet long and the stems nearly 4 feet long, were sent to the Agrostologist. During the long, hot, and dry spells of that year all of the varieties named showed excellent drought resistant properties, but the Australian saltbush particularly held its own most tenaciously. The Australian saltbush is known to be an excellent plant for soiling sheep, and sheep dealers in California use it a great deal in that way. It is stated on excellent authority that it develops better on alkali than on other soils; hence stockmen and farmers in the Pecos Valley country, where the soil is strongly impregnated with soda salts, will do well to test it fully. The recommendation is also made to those in other sections of Texas to sow fields to it, as on the ordinary soils it is reasonably certain to produce satisfactory results.

SANFOIN (*Onobrychis sativa*).

This is a deep-rooted perennial that was tested in 1899 and 1900 in the station garden with satisfactory results. Seeds which were sown May 4, 1899, in thin, gravelly soil on a hillside germinated well, and the plants grew to be 12 to 18 inches high. During the severe drought of that year they held their own better than the clovers, vetches, or alfalfas, and quite as well as the sulla. When the autumn rains began (October 26), the roots which had failed to some extent soon revived, and before the winter freezes began a rather vigorous new growth had developed. The lighter frosts and freezes did not injure the plants at all, but during the months of January and February, 1901, there was some severe weather which injured the foliage. By March, however, the roots again began to revive, and March 19 the new growth was from 6 to 10 inches long. Plants once well rooted will live a great many years if the soil is rich and the seasons favorable. Sanfoin produces a fair quantity of an excellent quality of forage that continues green during the late autumn and the early winter months, when green forage is scarce. It stands droughts remarkably well, and though the plants when young are liable to be winterkilled, when they are well protected they will not be killed in central Texas by any but very severe freezes. It is claimed for it that it is a superior hay plant, but the tests in the station garden rather indicate that it is much more valuable for pasture purposes. For the reasons stated its cultivation is recommended.

SWEET POTATO (*Convolvulus edulis*).

An interesting experiment was made in 1900 in connection with the station work with a view to determine if sweet-potato vines could be successfully baled and in that shape kept sweet for the purpose of winter feeding. From a field belonging to Mr. P. O. Forbus, near the station, some of them were secured when the tubers were almost or quite matured. They were cured about as readily as the vines of the several varieties of peas, but in curing they shrunk very much in bulk, and when cured were not nearly sufficient in quantity to make up a bale. The dry product, however, was kept dry, and late in the autumn was fed to cattle, which ate it quite greedily. The vines are known to be rich in fattening properties, and since the plant can be grown very cheaply throughout central Texas and converted into hay with but little trouble, and doubtless can be baled and in that shape as easily preserved as alfalfa, vetch, or pea vines, it is suggested that stockmen and farmers should save every vine grown by them for forage purposes.

TALLOW WEED (*Actinella linearifolia*).

The writer has long known this excellent forage plant in Texas. He first saw it in Tom Green, Concho, and Crockett counties when his

own stock fed on pastures of it, and demonstrated its wonderful fattening properties. Every sheep-raiser and cow-man in the stock-raising counties of Texas knows about it and values it highly for the forage it supplies. They call it tallow weed for the reason, as they give it, that the plant will put more tallow on the kidneys of cattle and other stock in a given time than any other native stuff, green or cured. As it makes its appearance on the range very early in the spring before anything else greens out, it has a value distinctly its own. It often grows 12 to 18 inches high on the range, has fragrant blossoms which develop into a rich seed head, and lives into the early summer months, but gives way under the influence of extremely long hot and dry periods. It revives in the autumn months, and frequently continues to furnish some green forage in the early winter months. The writer found another related species (*Amblyolepis setigera*) in the pasture of Mr. D. W. Middleton, of Abilene, Tex., growing luxuriantly in October, 1898. During the months of October and November, 1899, and in November, 1900, in a pasture of about 10 acres, between Abilene and the station, a fair proportion of the plants were green. Tests were made in the grass garden in 1899 and again in 1900 to determine its value as a hay plant. The plants were cut and efforts were made to cure them, but they molded and soured. As a green-forage plant it is one of the very best for central Texas, but as a hay plant it is extremely doubtful if it can be satisfactorily handled.

TEOSINTE (*Euchlæna luxurians*).

So much has been claimed for this very superior forage plant that much interest is being manifested in regard to it by stockmen and farmers of central Texas. Tests were made in the station garden to determine what it is really worth for live-stock purposes. Seeds received from the Agrostologist were planted in drills and in hills 4 feet apart each way April 10, 1898. By July 1 the plants had met in the rows; by July 15 the severe drought of that year was on, and by August 15 the plants had suffered seriously. The drought was not broken until October 26, by which time the plants and roots had failed entirely. The stalks grew 5 to 6 feet high and there was an abundance of fodder. Early in June some stalks were cut, cured, and baled, and months later were examined and found to be sweet. Some teosinte roots in the station garden, in spite of the drought, put out from 25 to 40 or more stalks, and it is confidently believed that a yield of 10 to 15 tons per acre can be secured in any fertile valley of central Texas. As the hay is much softer and more easily cured, baled, and handled than any of the sorghums known in the section, and as in years of normal rainfall it will certainly do well, stockmen and farmers should plant considerable areas of their fields to teosinte. Efforts were made in 1900 to secure some seeds with the view to making some further tests with it, but they were received too

late. It may be considered reasonably certain that it will not mature seeds so far north; but the astonishingly large quantity of stalks and



FIG. 6.—Teosinte.

fodder it produces makes it a very valuable forage plant for the section. In the Georgia Experiment Station it yielded 38,000 pounds of

green forage per acre, 40,000 pounds at the Mississippi station, and in Louisiana over 100,000 pounds. During droughty seasons it will not do well, and it will not pay to plant it in poor soil. (See fig. 6.)

CONCLUSION.

The foregoing statements report several fairly successful experiments made at the grass and forage plant station during three years from March 19, 1898, to March 19, 1901. As to the very large number of tests that did not give satisfactory results, it is hardly necessary to go into details. The impracticability of doing so will be understood in the light of the statement that quite 1,500 tests altogether were made during the term mentioned. In 1900, and to March 19, 1901, there were kept with the experimental work alone 656 separate accounts.

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BULLETINS OF THE BUREAU OF PLANT INDUSTRY.

The Bureau of Plant Industry, which was organized July 1, 1901, includes Vegetable Pathological and Physiological Investigations, Botanical Investigations and Experiments, Grass and Forage Plant Investigations, Pomological Investigations, and Gardens and Grounds, all of which were formerly separate divisions, and also Seed and Plant Introduction, the Arlington Experimental Farm, Tea Investigations and Experiments, and the Congressional Seed Distribution. Beginning with the date of organization of the Bureau, the independent series of bulletins of the Division of Agrostology, the last number of which was 25, and of each of the other divisions were discontinued, and all are now published as one series of the Bureau.

The bulletins published in this series are:

- No. 1. The Relation of Lime and Magnesia to Plant Growth. 1901.
2. Spermatogenesis and Fecundation of *Zamia*. 1901.
3. Macaroni Wheats. 1901.
4. Range Improvement in Arizona. 1901.
5. Seeds and Plants Imported through the Section of Seed and Plant Introduction, etc., Inventory No. 9. 1902.
6. A List of American Varieties of Peppers. 1902.
7. The Algerian Durum Wheats: A Classified List, with Descriptions. 1902.
8. A Collection of Economic and other Fungi, prepared for distribution. 1902.
9. The North American Species of *Spartina*. 1902.
10. Records of Seed Distribution and Cooperative Experiments with Grasses and Forage Plants. 1902.
11. Johnson Grass: Report on Investigations Made during the Season of 1901. 1902.
12. Stock Ranges of Northwestern California. 1902.

